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## Sharing the burdens? Empirical evidence on corporate tax incidence

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# Sharing the burden?

## Empirical evidence on corporate tax incidence

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### Abstract:

This study empirically investigates the direct incidence of the corporate income tax through wage bargaining, using an industry-region level panel data set on all corporations in Germany over the period 1998 to 2006. Our measure of direct incidence for the first time accounts for employment effects which result from tax induced wage changes. Workers share in reductions of the CIT burden; yet, direct incidence is small and confined to 0.19–0.29. Thus, the net effect of wage bargaining on the corporate wage bill, after an exogenous € 1 decrease in the CIT burden, is as little as 19 to 29 cents. This is about half of the effect obtained in prior literature under the assumption that employment remained constant. A focus on wages alone leads to an overestimation of direct tax incidence.

**JEL Classification:** H22, H25, J21, J31, H32

**Keywords:** tax incidence; wage determination; corporate income taxation; corporate tax return data

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# 1 Introduction

Who effectively bears the burden of the corporate income tax (CIT)? This question is addressed by the economic incidence of the CIT, which is a central issue in tax policy, as it determines the distributional effects of the tax system. For many policy makers, the CIT is not only an important source of government income but also offers the opportunity to increase the progressivity of the tax system. This view, however, only holds true if the tax burden is effectively borne by capital owners and not shifted on to workers (or consumers). Despite its policy relevance, no consensus about the economic size of corporate tax incidence has been achieved. To date, the distributional effects of CIT reforms remain unclear, as the matter about who effectively bears the burden of the CIT has not been settled academically.

The literature distinguishes two pathways through which the CIT can be passed on to labour: indirect and direct incidence. Indirect incidence refers to tax effects working through the level of pre-tax profits, determined by investment and by output prices (Harberger 1962). Direct incidence, for given pre-tax profits (Arulampalam, Devereux, and Maffini 2012), arises as corporate taxes reduce the quasi-rent over which employers and workers can bargain.

This paper makes three novel contributions to the small literature on *direct* incidence of corporate taxes, building on the work by Arulampalam et al. (2012): We use industry-region level data to match the level at which wage bargaining typically takes place in Germany, we identify incidence based on exogenous within-country variation in the CIT burden, and we allow taxes to affect both wage rates and employment. More generally, our analysis sheds light on CIT incidence in environments with collective wage bargaining at branch or sectoral level, which is applicable for most continental European countries (OECD 2004).

First, we use information at the industry-region level to account for the fact that wage bargaining in Germany typically takes place at this level. At the industry-region level, the data set combines comprehensive CIT return and Social Security payroll information for the universe of German corporations and their employees during the period 1998–2006. The panel data set is rich in labour market variables and tax information. It enables us to fully exploit the heterogeneity in industries' tax burdens and thus in their conditions for collective wage bargaining.

Second, we use exogenous variation in the corporate tax burden to identify tax incidence. The change in effective corporate tax burdens varies across industry-region units of observation and over time because of two major CIT reforms in Germany during our observation period. We measure the tax burden using average tax rates (ATR). As the ATR is likely endogenous with regard to wage rate decisions, we instrument the ATR with a counterfactual ATR derived from a microsimulation model. Thus, we identify tax incidence exclusively based on exogenous within-

country variation in the CIT burden (and then relate changes in the ATR to changes in the statutory CIT, which is the variable policymakers can directly decide upon).

Third, we introduce effects of the CIT on employment by allowing labour demand to respond to the wage rate. A change in the wage rate triggers a *movement along* the labour demand curve. We argue that movements along the demand curve were most likely to occur in Germany during our observation period, as wage negotiations largely followed the right-to-manage framework: Worker representatives and employers Nash-bargained over the wage rate, with firms retaining the right to subsequently adjust their workforce (Nickell and Andrews 1983). After a tax cut, it might have been that worker representatives interested in higher wages (and not in adding new employees) negotiated a large increase in wage rates. However, firms might have undone part of the increase in total wage costs by laying some of their workers off. When determining tax effects on the corporate wage bill it is thus essential to take into account employment decisions, as an imminent consequence of the wage bargaining process. Our empirical framework reflects the institutional setting in our observation period and allows us to calculate the *net* tax effect of wage bargaining on the corporate wage bill.

Overall, a tax cut might well spur employment: A *shift of* the labour demand curve may increase employment, overcompensating the unambiguously negative employment effect caused by the movement along the labour demand curve described above. A reduction in (marginal) CIT rates, lowering the user cost of capital and enhancing capital formation, can increase overall employment as a larger capital stock allows greater economic output (scale effect).<sup>3</sup> This positive scale effect is what policy makers have in mind when they call for cuts in corporate tax rates in order to spur employment. Tax-related changes in capital formation and output impact the level of pre-tax profits, and are part of *indirect* incidence and not the focus of our study. However, to put our employment effects estimated for direct incidence into perspective, we also report estimates for the number of additional employees that can be ascribed to greater capital stock.

In the following we briefly review the literature on tax incidence, distinguishing theoretical and empirical contributions. The theoretical literature on corporate tax incidence dates back to Harberger (1962). He develops a model of a closed economy with two competitive sectors, a corporate and a non-corporate sector. Both sectors in his model use two factors of production,

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<sup>3</sup> The effect of the CIT on employment, working through capital stock, can also be negative: depending on the degree of substitution between capital and labour, larger capital stock might also result in a decrease of employment, shifting the labour demand curve inwards (substitution effect). Thus, the net effect of the increase in capital stock on employment depends on the relative sizes of the scale and the substitution effects. Whether the scale or the substitution effect dominates is an empirical question. Courseuil and de Moura (2011) find that a tax cut increases overall employment. They examine a tax incentive program for small businesses in Brazil, which reduced the monetary and administrative costs for micro-firms. The authors report that the program has increased employment by 6% to 7.5%, on average. It is important to note, however, that the study makes the strong and contestable assumption that wage rates remain unaffected by a change in taxes.

capital and labour, which are in fixed and immobile supply. Harberger shows that under a variety of plausible assumptions capital owners in both sectors bear the full tax burden if a tax on capital gets implemented in the corporate sector. Several subsequent studies have added other features to the model, such as more subsectors, dynamics, uncertainty, and imperfect competition (for a review, see Auerbach 2005). Altogether, these models suggest that capital bears a substantial part, if not all, of the tax burden.

However, the result showing that capital bears the lion's share of the corporate tax burden strongly depends on the assumption of a closed economy. Bradford (1978) and Kotlikoff and Summers (1987) show that a tax on corporate capital in an open economy with free capital flows leads to a flight of capital, which reduces the return to labour in the home country. Thus, in an open economy with mobile capital but immobile labour force, labour effectively bears the burden of a corporate tax. A variety of more sophisticated general equilibrium models (Gravelle and Smetters 2006; Randolph 2006; Harberger 1995, 2006) analyse the incidence of a corporate tax in an open economy. These models show that the share of the corporate tax burden falling on labour crucially depends on factor mobility, factor substitution, relative capital intensities of the sectors, international product substitution, and the size of the country introducing the tax. Labour in these studies is found to bear virtually none or more than 100% of the corporate tax, depending on the assumptions made.

Empirical evidence on corporate tax incidence was only provided very recently. Most of the econometric studies on corporate tax incidence use variation in wages and taxes at the country-year level to identify the impact of the corporate tax on wages. The literature can be grouped according to the level of analysis (country vs. firm level). Except for one single study all papers reviewed exploit variation in statutory corporate tax rates to identify tax incidence. We will first review studies based on country level data and then move on to studies carried out with firm level data.

Hassett and Mathur (2006) estimate the effect of corporate tax rates on the average wage earned in manufacturing, using a panel on 72 countries over the period of 1981-2002. They find that wages are significantly responsive to corporate taxes, especially in smaller countries. The estimations based on aggregate data do not allow to separate tax effects from institutional conditions: Cross-country differences in wage-setting institutions potentially correlate with tax rate differentials, and appropriate controls cannot be used with country-level data. Desai, Foley, and Hines (2007) use aggregate data on the foreign activities of American multinationals in about 50 countries in 1989-2004. Applying the restriction that the overall corporate tax burden is shared between workers and capital owners, they find that labour bears 45% to 75% of the tax burden. Forcing the shares of the tax borne by capital owners and workers to sum up to unity, however, neither allows for excess

burden of taxation nor for consumers to bear part of the tax through higher prices. This might result in an under- or overestimation of the corporate tax burden borne by labour.

More recent papers have been based on firm-level data. Fuest, Peichl, and Siegloch (2012) exploit variation in statutory local tax rates across German municipalities between 1998 and 2008 to identify tax incidence. Statutory local tax rates vary as municipalities set collection rates locally. Fuest et al. conclude that an increase in the marginal corporate tax rate by 1% reduces monthly wages by 0.18%, on average. In a very similar approach, but estimated on slightly more aggregated data from 1995-2004, Bauer, Kasten, and Siemers (2012) find an elasticity estimate of daily wages with respect to the marginal business tax rate of -0.28 and -0.46. Both studies use variation in municipal collection rates and do some back-on-the-envelope calculations to link municipal collection rates and firm-specific effective corporate tax rates. The municipal collection rates, however, do not map on the corporate tax burden. The latter additionally depends on the definition of the corporate tax base and on corporate income tax rates. In 2001, a major corporate tax reform in Germany broadened the tax base and significantly altered corporate income taxation, potentially confounding the estimates of corporate tax incidence in both of these studies.

This very corporate tax reform is evaluated by Aus dem Moore, Kasten, and Schmidt (2010). In a difference-in-differences analysis they compare the wages paid by German firms to those paid by their French and British counterparts. The identifying assumption of this approach is that German and French (British) firms in their data set were underlying a common trend over the period 1996-2005. Assuming that this assumption holds, they find a significant and positive effect of the cut in the CIT rate on wages.

The study by Arulampalam et al. (2012) exploits firm and time-specific variation in effective corporate tax rates to identify direct incidence. Their estimates for the direct effect of taxation on labour suggest that about half of a tax increase is passed on to wages in the long run. This estimate is for the wage effect only; adjustments in employment in response to changes in the wage rate are neglected.<sup>4</sup>

The empirical analysis in this paper differs from these studies in several important respects, defining our main contributions described earlier: First, our analysis reflects that the bargaining outcome is determined by the industry-region wide average tax burden, as wage bargaining agreements are made at the industry-region level in Germany (see Section 2). Even though collective bargaining at the sector level is also typical for the European countries studied earlier, previous literature had to resort to firm specific or country wide measures as a proxy of the average

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<sup>4</sup> Note that the empirical analysis in Arulampalam et al. (2012) deviates from the efficient wage bargaining model laid out in the theoretical part of the paper, as it abstracts from the first-order condition of employment. Conditioning the estimations on value added per worker is not sufficient for holding potential margins of adjustment fixed, including output and employment. Adjustments in the use of capital and labour might still take place but sum to zero overall.

tax burden. Second, exogenous variation in the change of the CIT burden across industries and over time enables us to identify CIT incidence within one country. So far, the majority of studies in the field had to fall back on cross-country variation and thus measured tax incidence for the average of different institutional settings present in the national labour markets and tax legislations. Third, we disentangle tax effects on the price of labour and the quantity of labour demanded. Instead of making the strong assumption that total labour demand is unchanged after a corporate tax reform, we consider changes in hours worked and in the number of employees.

We provide empirical evidence that it is crucial to take employment effects into account when calculating direct CIT incidence. Our central estimates show that workers share in reductions of the CIT burden, although direct incidence is small: Wage bargaining, after an exogenous € 1 decrease in the CIT burden, effectively increases the corporate wage bill by as little as 19 to 29 cents. This is about half of the effect obtained in prior literature under the assumption that employment remained constant. Using our data set and ignoring any wage-related changes in employment, we reproduce the estimates found in prior literature. A comparison of direct incidence between estimations with and without employment responses confirms that merely focussing on wages leads to an overestimation of direct tax incidence.

The paper is organised as follows. In the next section, we present the institutional background of wage bargaining in Germany and introduce the right-to-manage model underlying our analysis. Section 3 describes how we calculate the share of the CIT burden shifted on to labour. Section 4 introduces our industry-region level panel data set and the micro data sets behind. Section 5 presents the sources of the exogenous variation in the change of the CIT burden across industries and over time and discusses various econometric issues. Section 6 presents the results, and Section 7 concludes.

## **2 Wage Bargaining in Germany**

This section details the institutional and theoretical foundations of our analysis of direct CIT incidence. We briefly describe the institutional background of wage bargaining in Germany, introduce the right-to-manage framework, and discuss how this framework is reflected in our empirical estimations.

Let us begin by reviewing the three main features of the institutional regulations and the wage bargaining process prevalent in Germany during our observation period: industry-region level bargaining, wide coverage by collective agreements, and extension of wage settlements to non-union employees.

First, wage bargaining typically takes place at the industry level of a region, where region mostly refers to one of the German federal states. Germany is similar to other continental European

countries in that wages are bargained at the industry level. It differs from the United States or Japan, where wages are usually bargained at the level of the individual firm, and it differs from the Nordic countries, where national unions and employer associations engage in inter-industry bargaining at the national level (OECD 2004).

Second, because of high collective bargaining coverage in Germany, wage rates and conditions of employment are primarily subject to union-negotiated terms. At the outset of our observation period, bargaining coverage was above 90% in Germany (Nickell, Ochel, and Quintini 2003). That is, more than 90% of total employees were covered by a collective agreement negotiated between employers and unions.

Third, though the outcome of the wage settlement is negotiated between unions and the regional employers' association, it usually also covers non-union members. Collective agreements are legally only binding for members of the negotiating parties but it has become common practice to extend the wage agreement to a firm's total workforce, whether unionised or not. The reasons for extension are various and include the principle of equal treatment and the intention to not indirectly promote unionisation (for a discussion of the reasons see Fitzenberger and Franz 1999). Because of extension, coverage by collective agreements does not depend on individual union membership in Germany.

The fact that the majority of employees have their wage rates determined by collective bargaining has important implications on the level of employment. In particular, there is some evidence that high levels of bargaining coverage are associated with higher wage rates and lower employment rates (e.g., Aidt and Tzannatos 2008; Nickell and Layard 1999). First, this evidence indicates that worker representatives have the potential to increase wage rates above the competitive level, so that wages are partly determined by sharing in quasi-rents (e.g., Christofides and Oswald 1992; Blanchflower, Oswald, and Sanfey 1996; Van Reenen 1996). And second, it shows that worker representatives negotiate inefficiently high wage rates, accepting unemployment as their preferences vary between wage rates and employment (see Nickell et al. 2003, for example).<sup>5</sup> A preference for wage increases at the expense of employment arises whenever some majority of workers know themselves to be insulated from job cuts (as reductions in the labour force are, for instance, by inverse seniority with the firm, see Oswald 1993 and Mitchell 1972).

In the right-to-manage model, unemployment can occur if wage rates are set inefficiently high: Wage rates are subject to negotiation, while firms remain free to unilaterally choose employment once wage rates have been set<sup>6</sup> (Pencavel 1985, Nickell and Andrews 1983, Oswald 1982). That is,

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<sup>5</sup> This also suggests that unemployment levels in previous periods do not feed back on wage rates.

<sup>6</sup> In that respect the right-to-manage model differs from the efficient wage bargaining model, in which both wage rates and employment are chosen in the bargaining process between employers' associations and unions.



once the contract specifying the wage rate has been negotiated, employers take the wage rate as given and try to increase their welfare by reducing employment.

In our period of observation, what is observed empirically matches the predictions derived in a right-to-manage model fairly well. As the model would predict, the increase in real wage rates was accompanied by a decline in employment between 1999 and 2003. Furthermore, throughout our observation period, we see overall unemployment persisting at a high level, and no apparent impact of unemployment on the wage bargaining process.<sup>7</sup>

From the institutional regulations and the empirical observations, we conclude that we can approximate wage bargaining with the right-to-manage model reasonably well: Germany during our observation period was characterised by collective bargaining agreements on wage rates that were negotiated at the industry-region level, covered the majority of workers, and lead to an increase in wage rates at the expense of employment. The literature supports the view that the right-to-manage model applies to Germany at the turn of the century (e.g., Cahuc and Zylberberg 2004, Layard, Nickell, and Jackman 1991).

The institutional and theoretical backgrounds laid out in this section determine our empirical analysis in three important ways. First, we use industry-regional level data to mirror collective wage bargaining. Second, we take account of employment responses as negotiated wage rates only partly capture direct CIT incidence. Third, in our estimations, we follow the right-to-manage framework in that we separate tax-related responses in the wage rate from the firms' hiring and firing decisions.

### **3 Capturing Incidence**

This section describes how we calculate the share of the CIT burden that is shifted on to labour. We first introduce the corporate wage bill as a variable that summarizes different labour market outcomes. Then, we discuss the theoretical predictions of the effect of an exogenous change in the statutory CIT rate on the corporate wage bill. Last, we calculate the tax elasticity of the corporate wage bill in order to determine the elasticities which need to be estimated in our empirical work below.

#### **3.1 The Corporate Wage Bill**

The corporate wage bill summarises all relevant labour market outcomes: wage rates paid, hours worked, and number of employees. While the wage rate reflects the price of labour, both hours worked and the number of employees refer to the quantity of labour demanded. As we will discuss below, the price and the quantity components of the corporate wage bill are differently – or even

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<sup>7</sup> This has changed only recently in the wake of strongly declining trade-union membership rates and increased international competition through the introduction of employment protection clauses in union wage contracts (see Addison et al. 2007).

oppositely – affected by changes to the statutory CIT rate. In order to fully picture the tax burden shifted on to labour, then, it is important to separately take these margins into account, instead of focusing on wages only.

The corporate wage bill is defined as the product of the wage rate ( $w$ ) and total labour demanded ( $L^d$ ):

$$\text{corporate wage bill} = w(\text{ATR}(\tau)) \times L^d(w(\text{ATR}(\tau))). \quad (1)$$

Labour demanded is in full-time equivalents, summarising hours worked per employee and the number of the employed.<sup>8</sup> It is determined by the wage rate as the price of labour ( $w$ ), which negatively depends on the ATR (a larger tax burden reduces the quasi-rent to be bargained over, given pre-tax profits). The ATR is a function of the statutory proportional CIT rate ( $\tau$ ).

### 3.2 Tax-Related Effects on the Corporate Wage Bill

Next, we discuss the theoretical predictions of the effect of an exogenous change in the statutory CIT rate on the corporate wage bill. Taking the derivative of the corporate wage bill with respect to the statutory CIT rate  $\tau$  generates:

$$\frac{\partial \text{corporate wage bill}}{\partial \tau} = \frac{\partial w}{\partial \text{ATR}} \frac{\partial \text{ATR}}{\partial \tau} L^d + w \left[ \frac{\partial L^d}{\partial w} \frac{\partial w}{\partial \text{ATR}} \frac{\partial \text{ATR}}{\partial \tau} \right] \quad (2)$$

Eq. (2) shows two effects of the CIT on the wage bill: The first effect is expressed by the term  $\frac{\partial w}{\partial \text{ATR}} \frac{\partial \text{ATR}}{\partial \tau} L^d$  and describes the CIT effect on wage rates. The second summand,  $w \left[ \frac{\partial L^d}{\partial w} \frac{\partial w}{\partial \text{ATR}} \frac{\partial \text{ATR}}{\partial \tau} \right]$ , describes the effect of the CIT on employment, operating through the price of labour. We now describe the two effects in detail.

The *first effect of the CIT* on the corporate wage bill is *related to wage rates* and arises from bargaining over economic quasi-rents. A lower CIT burden increases the size of the quasi-rent to be bargained over, for a given pre-tax profit. Through wage bargaining, workers not only directly share in the after-tax quasi-rent but also in the CIT burden (see Arulampalam et al. 2012).<sup>9</sup> Note that a linear tax on corporate profits impacts the wage rate in a right-to-manage model irrespectively of whether or not labour and capital depreciation are expensed. If an entrepreneur's outside option is larger than zero, a profit tax on corporate income decreases wages in the right-to-manage model, provided that the tax does not affect the entrepreneur's outside option by more than it reduces

<sup>8</sup> In our empirical part we account for changes in hours worked per employee by using hourly wage rates and by conditioning all estimations on the share of full-time employees.

<sup>9</sup> To see this in the right-to-manage framework, we need to expand the standard model through the inclusion of the ATR on corporate income. This shows that the bargained wage rate is a decreasing function of the ATR on corporate profits.

profits (Goerke 1996). This can reasonably be assumed under the current provisions and rate structures of the German tax system. In addition, firms' profit-maximising behaviour only remains unaffected by a profit tax if the tax falls on pure profits (Atkinson and Stiglitz 1987, lecture five). It is anything but straightforward to apply the theoretical concept of pure profits to the definition of the real world tax base. Also, depreciation allowances for tax purposes, for instance, are often set with economic growth or structural change in mind, rather than with the goal of fully matching economic depreciation. All of these arguments suggest that a direct effect of the CIT on the wage rate is present.

In addition to the direct effect of the CIT, wage rates are potentially indirectly affected by the CIT through the level of pre-tax profits. We do not attempt to estimate this indirect effect of the CIT on wage rates. As extensively discussed in Arulampalam et al. (2012), identification of indirect incidence is precluded by general equilibrium effects simultaneously affecting labour productivity, capital stock, and output. We therefore limit ourselves, while controlling for other factors, to the direct effect of the CIT on wage rates.

The *second effect of the CIT* on the corporate wage bill is related to *labour demand*. Any change in wage rate affects the level of employment through a movement along the labour demand curve. In the previous section, we saw that employers unilaterally adjust the level of employment once the (bargained) wage rate is known: If worker representatives negotiate a higher wage rate following a cut in the CIT burden, this might lead to a reduction in employment. For a given level of pre-tax profits, a decrease in the CIT burden thus leads to a *lower* level of employment, transmitted through the wage bargaining process. The reduction in the number of employees and the tax-related increase in wage rates discussed earlier are opposites in terms of their effects on the size of the corporate wage bill.

Combining the first and second effects of the CIT on the corporate wage bill leads to the direct incidence of the tax.

### 3.3 Combining the Effects in the Elasticity of the Corporate Wage Bill

In our empirical estimations below we identify tax-related effects on both wage rates and labour demanded. Since we estimate elasticities, it is useful to rewrite eq. (2) in elasticities. This leads to the elasticity of the corporate wage bill with respect to the statutory CIT rate:

$$\begin{aligned} \eta_{wage\ bill, \tau} &= \left[ 1 + \left( \frac{\Delta L^d}{\Delta w} \right) \times \left( \frac{w}{L^d} \right) \right] \times \left( \frac{\Delta w}{\Delta ATR} \right) \times \left( \frac{ATR}{w} \right) \times \left( \frac{\Delta ATR}{\Delta \tau} \right) \times \left( \frac{\tau}{ATR} \right) \\ &= \left[ 1 + \eta_{L^d, w} \right] \times \eta_{w, ATR} \times \eta_{ATR, \tau} \end{aligned} \quad (3)$$

$$\text{with } \eta_{L^d, w} = \frac{\partial L^d}{\partial w} \frac{w}{L^d}, \eta_{w, ATR} = \frac{\partial w}{\partial ATR} \frac{ATR}{w}, \text{ and } \eta_{ATR, \tau} = \frac{\partial ATR}{\partial \tau} \frac{\tau}{ATR}.$$

Eq. (3) summarises our empirical approach. We analyse how exogenous changes in the statutory CIT rate affect the corporate wage bill. In our study, we differentiate the impact of the CIT on wage rates from its effect on employment (operating through wage bargaining). While the wage related effect of a cut in CIT rates on the corporate wage bill is unambiguously positive, the ensuing employment reduction is opposite in terms of effect on the size of the corporate wage bill. The net increase in the corporate wage bill in response to a cut in the statutory CIT rate will depend on the relative magnitudes of the tax elasticity of the wage rate ( $\eta_{w,ATR}$ ), the wage elasticity of employment ( $\eta_{L^d,w}$ ), and the elasticity of the ATR with respect to the statutory CIT rate ( $\eta_{ATR,\tau}$ ). All of these elasticities determine direct incidence and are estimated in the empirical work below. We do not attempt to estimate indirect or total CIT incidence, which would need to include tax effects on pre-tax profits from capital stock, labour productivity, and output.

## 4 Data

Our panel data set spans the observation period from 1998 to 2006. As discussed in Section 2, collective wage bargaining takes place at the industry-region level in Germany. In our empirical analysis, we mirror these institutional conditions, using industry-region groups as units of observation. To construct our units of observation, we aggregated firm-specific tax information and individual level labour market data to the industry-region level.<sup>10</sup> In Section 4.1, we describe how the micro data sets were aggregated. Sections 0 and 4.3 introduce the corporate tax return and labour market data. Finally, Section 4.4 provides descriptive statistics on tax and labour market variables.

### 4.1 Level of Analysis: Industry-Region Group

We aggregated and combined several micro data sets to obtain a panel data set at the industry-region level covering tax and labour information. More precisely, we grouped corporations and individual employees by industry and region.<sup>11</sup> Because all the micro data sets used for aggregation each cover all German corporations and their employees, averages at the industry-region group level correspond to the population group averages.

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<sup>10</sup> Note that aggregation also allows us to combine tax return and labour market data. For data protection reasons it would not be allowed to match tax return data with information on employees at the level of the individual corporation.

<sup>11</sup> For corporations with several establishments, the region was assigned according to the geographic location of their headquarters. To address slight changes in the classification of industries between 1998 and 2001, we matched prior industry identifiers to new ones. This match was not always possible, so we rearranged a few groups to make the data sets for the two years comparable. We exclude observations for which the industry was unknown or obviously erroneous. Revealing the industry is compulsory but leaves taxes for a given corporation unchanged; it is unlikely that there would be any systematic concealment of industry. Therefore, discarding these observations should not bias our results. We also drop all private households from the data set because they were only partly included in the 1998 data set and are not the focus of our study.

We aim at a grouping which closely reflects the geographical and industrial level of wage negotiation. Unfortunately, information is available neither on the precise regional level at which negotiations were conducted nor on whether sub-industries reached a joint wage settlement or not. Yet, we know that the level of negotiation is mainly determined by the size of the industry: Large industries usually bargain at the federal states level, while industries containing few firms are more likely to bargain at a superordinate region- or industry-level. This insight led us to group together corporations which were operating in the same sub-industry (five-digit industry code) and in the same federal state while imposing a minimum group size of 50 corporations.<sup>12</sup>

To ensure a group size of at least 50 corporations, we aggregated the data by applying a sequential procedure running from detailed to rougher industry and region classifications (see chart in the Online Appendix A). That is, we assessed the number of corporations within each group initially constructed at the five-digit industry level, with differentiation along federal states. If there were more than 50 corporations in a group, it was kept. Otherwise, we went for a slightly more aggregated grouping at the five-digit industry level, omitting the differentiation along federal states, and instead using East versus West Germany. In this way, we kept industry-region groups covering at least 50 corporations and grouped the other corporations on the superordinate level. Following this procedure, each corporation was assigned to one of 856 groups.

## **4.2 Corporate Tax Return Data**

The industry-region level information on the tax burden, capital, and output stems from corporate tax return data from 1998 to 2006. Tax return data consist of all (unconsolidated) tax returns filed in a given year<sup>13</sup> and offer several distinct advantages compared with accounting data used in prior literature. First, tax return data represent all corporations subject to the German CIT, which means nearly 740,000 firms in 1998 and about 860,000 in 2004. Second, they provide detailed information on the tax assessed and on all reported items, together with firm characteristics such as industry, region, and legal form. This information enables us to construct firm-specific variables in the first place and to subsequently aggregate these variables to our industry-region level of analysis. To build the variables of interest, we resort to three different sources of corporate tax return data, compiled by the German Federal Statistical Offices: CIT statistics, local business tax statistics, and value added tax statistics.

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<sup>12</sup> A minimum group size of 50 corporations was also imposed to make sure that the industry-region fixed effect remained unaffected by firm exit and entry (we cannot drop firms entering/leaving as the corporate tax return micro data are currently not available as a panel). Industry classification and location of headquarter usually remain constant. We do not expect corporations to change their industry classifications or to relocate their headquarters in the short time horizon of our data set or in response to the tax reform. Differencing should thus eliminate any time invariant differences between industry-region groups.

<sup>13</sup> For reasons of data protection, individual data are anonymised. Researchers can access the data through the research centres of the Statistical Offices ([www.forschungsdatenzentrum.de/en/index.asp](http://www.forschungsdatenzentrum.de/en/index.asp)).

Our measure of the corporate income tax burden of an industry-region group is based upon the German CIT statistics, which are published every three years.<sup>14</sup> The latest year available is 2004, so that we can use tax variations of the years 1998, 2001, and 2004 to measure CIT incidence. In each year  $t$ , we calculate the firm  $f$  specific average tax burden, which is then aggregated to the average tax rate (ATR) of an industry-region group  $g$ :

$$ATR_{g,t} = \frac{1}{N_{g,t}} \sum_{f=1}^{N_{g,t}} \frac{CIT\ assessed_{f,t}}{NPBL_{f,t}}, \quad (4)$$

where NPBL is net profit before loss carry-over.

The ATR measures the percentage of pre-tax profits in an industry-region group that has to be paid in corporate income taxes, and, thus the tax curtailment in the quasi-rent that workers and employers can bargain over. An industry-region's ATR differs from the statutory rate because of tax credits for foreign-source income and because of the difference between NPBL and taxable income, which is mainly driven by losses brought forward from earlier periods<sup>15</sup> (see Online Appendix B).

We use the sum of equity, debt, and the legal minimum deposit, which amounts to 25,000 euros for private limited liability companies and to 50,000 euros for public companies as a proxy for total capital, the second production factor. Equity is recorded in the CIT return tax statistics. Long-term debt can be derived from the local business tax statistics<sup>16</sup>, which are available for the years 1998, 2001, and 2004 (see Online Appendix C1).

Sales from the yearly value added tax (VAT) statistics<sup>17</sup> are used as a measure for output. Because exports are not liable to VAT in Germany, they are not included in our sales variable. The VAT statistics are the only data source available at the industry-region level; therefore, we cannot adjust the sales data for export shares. However, if export shares do not change in the observation

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<sup>14</sup> English-language information on the corporate income tax statistics is available at <https://www.destatis.de/EN/FactsFigures/SocietyState/PublicFinanceTaxes/Taxes/CorporationTax/CorporationTax.html>.

<sup>15</sup> The amount of a corporation's tax loss carry-back and carry-forward is deductible against current profits. In Germany, a net operating loss does not lead to an immediate tax rebate but is deductible against positive profits from other years. Companies that have paid corporate income tax in the year(s) before may carry back the loss and receive a tax refund. If the loss in the following year exceeds profits or a legally defined maximum carry-back, the remaining loss must be carried forward in time; the resulting tax loss carry-forward, which is valid for an unlimited period of time, is deductible against future positive profits.

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

<sup>16</sup> English-language information on the local business tax statistics is available at <https://www.destatis.de/EN/FactsFigures/SocietyState/PublicFinanceTaxes/Taxes/TradeTax/TradeTax.html>.

<sup>17</sup> English-language information on the value added tax statistics is available at <https://www.destatis.de/EN/FactsFigures/SocietyState/PublicFinanceTaxes/Taxes/TurnoverTax/TurnoverTax.html>.

period, this measurement error should be accounted for by the group fixed effects, such that they are purged from the first-differenced regression. This assumption also holds for shocks to wage rates, which may affect the volume of sales as long as this relation has not changed during the observation period.

To estimate the number of additional employees ascribed to greater capital stock, we need a measure of the price of capital. We employ the user cost of capital, which is the minimal rate of return that must be earned on an investment project before taxes to break even. Following its standard definition, we calculate the user cost of capital based on input and output prices, interest rates, economic depreciation, and depreciation allowances (for details see Dwenger (forthcoming)).

### 4.3 Labour Market Data

All labour market variables are based on the full record of those 32 million individuals, who were employed in Germany between 1998 and 2006. The data is collected by the Federal Employment Agency from two sources: First, every employer has to notify the agency whenever a new employee enters the workforce or leaves the establishment. Second, employers report on all their current employees at the end of each calendar year. For scientific use, the research institute of the Federal Employment Agency (IAB) assembles the data in the historical files of Social Security.

The data set contains individual level information on employment status, on monthly wages, and on personal characteristics such as age, sex, and work experience. Importantly, it also provides information on the industry, region, and size of the employer. These variables allow us to aggregate the information on each employee to obtain the characteristics of the average workforce in an industry-region group.

Before describing the aggregated variables, we would like to mention two details of how we constructed them at the level of the individual employee. First, employers report monthly wages to the Federal Employment Agency. We calculate the hourly wage rate for each individual  $i$  as their monthly wage divided by the hours worked. For this purpose, we imputed data on working hours from the Microcensus<sup>18</sup> (Online Appendix C2); in the imputation, we differentiated 300 subgroups with regard to industry, gender, region, employment type (full-time, part-time, marginal), and education (low, medium, high). Second, data on marginally employed people appear in the Social Security system only from the second quarter of 1999 onwards.<sup>19</sup> We use the development of employment and wage rates of the marginally employed between the first quarter and the remainder

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<sup>18</sup> The Microcensus (which includes the official labour force survey, *Arbeitskräfteerhebung*) provides official representative statistics on the population and the labour market in Germany, including hours worked (see Online Appendix C2). Detailed information about the Microcensus is available from <http://www.gesis.org/en/services/data-analysis/official-microdata/microcensus/>.

<sup>19</sup> Marginal employment covers employment at low working hours and earnings with reduced social security contributions.

of the year through 2000 to extrapolate the number of marginally employed people and their wage rates for the first quarter of 1999 (Online Appendix C3).

We aggregate all individual characteristics to the industry-region level. For each industry-region group, we obtain the number of people employed, the median wage rate paid, and a set of explanatory variables. To avoid oversampling of individuals with longer employment spells, we weighted observations according to the length of employment (for details, see Online Appendix C4). The average number of people employed in each year is the sum of monthly employment divided by 12. The median wage rate is drawn from the yearly distribution of wage rates within an industry-region group. We resort to median wage rates (instead of using average wage rates) to avoid any censoring from above in the wage variable: In the upper part of the wage distribution, observations are censored at the Social Security assessment ceiling, which for unemployment and old age insurance was 51,538 euros/year (42,949 euros/ year) in 1998 and 63,000 euros/year (52,800/year euros) in 2006 for West (East) Germany. The 50th percentile of wages is always below the Social Security assessment ceiling, so that we can circumvent any problem of censoring by using median hourly wage rates. The median wage rate is also the pertinent measure if wage bargaining behaviour is determined by the median voter rule: In this case, the median individual exactly is the person with the median wage rate. To control for the composition of the workforce in an industry-region group, we computed average values for age, establishment size and work experience, each weighted by the number of employees in a given month and year. We also constructed variables reflecting the share of women, foreigners, and full-time employees in an industry-region group.

#### **4.4 Descriptive Statistics**

In Tables 1a and 1b, we present the means and standard deviations of our labour market and tax variables, measured at the industry-region level. All variables in nominal monetary terms (i.e., wage rates, sales, and capital) are deflated using producer price indices of the corresponding industries from the German Federal Statistical Office.<sup>20</sup> We use producer price indices for deflation to partial out any adjustment in output prices that might result from a change in taxation.

Median wage rates for all employees amounted to about 11.49 euros per hour in 1999. After a compression in 2000, real wage rates began rising in 2001, before contracting again since 2004. On average, firms employed between 35,000 and 37,000 individuals in our observation period. The

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<sup>20</sup> The main producer price indices we used were the producer price indices for industrial products, agricultural products, and services. For a few industries in the services sector, consumer price indices had to be used as a substitute. Information on all of these price indices is available online: <https://www.destatis.de/EN/FactsFigures/NationalEconomyEnvironment/Prices/Prices.html>.



shares of women, foreigners, and full-time employees showed a stable pattern in group averages across time.

< Tables 1a and 1b about here >

As Table 1b shows, the Tax Relief Act reduced the ATR by 4 percentage points on average, from 11.5% in 1998 to 7.5% in 2001. In 2004, the newly introduced cap on the use of tax losses carried forward slightly increased the ATR to 7.7%.<sup>21</sup> Compared with a drop in the statutory tax rate by 20 percentage points for most corporations (Sections 5.1 and 5.2), the reduction in ATR was much smaller. Various factors contributed to this difference, which we exploit to identify tax incidence (Section 5.2).

After an increase from 0.163 in 1998 to 0.181 in 2000, the user cost of capital again receded to lower levels following the Tax Relief Act (2001: 0.168, 2006: 0.146). The potential loss carry-forward nearly doubled, on average, between 1998 (690,000 euros) and 2004 (1.2 million euros). Economic activity, as measured by average sales in real terms, increased steadily from 284 million euros in 1998 to 374 million euros in 2006. Total capital increased from 4.4 million euros in 1998 to 6.7 million euros in 2006.

## **5 Identification and Empirical Model**

Our identification of corporate income tax incidence comes from exogenous variation in the change of the CIT burden across groups between 1998 and 2006. In Section 5.1 we briefly present the German CIT system of 1998 and describe the tax reforms undertaken during our observation period. Section 5.2 provides a discussion of how firms, and thus our industry-region groups, were affected differently by the reforms. In Section 5.3 we describe our empirical model of the wage and employment equations and discuss various econometric issues.

### **5.1 The German CIT System 1998 - 2004: Structure and Tax Reforms**

In Germany, as elsewhere, the CIT is levied on corporate enterprises, public and private limited companies, and other corporations (e.g., cooperatives, associations, foundations). Sole proprietorships and partnerships are not subject to the CIT; profits earned by a non-incorporated firm are attributed to the firm's individual partners and taxed according to their personal income tax

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<sup>21</sup> Our average tax rates are lower when compared with other measures of effective tax rates in Germany for our observation period (e.g., Buijink et al. 1999; Nicodème 2001). Comparability across studies is limited though, because our measure is based on actually assessed taxes and NPBL, whereas prior studies use the tax burden related to the profit in commercial or consolidated balance sheets. Instead, we recognize that profits can be offset against losses from other periods to lower the average ATR in a given year. ATRs also differ from those based on aggregate revenue data published by the OECD and the European Commission (2003), which use not assessed but prepaid corporate taxes. In Germany, prepaid taxes correlate only weakly with assessed taxes in any given year. For example, in 2001 prepaid corporate taxes were virtually zero, whereas assessed corporate taxes amounted to about 20 billion Euros.

schedules. The assessment base of the CIT, or taxable income, can be derived from the amount of profits recorded in the tax balance sheet (see Online Appendix B).

Initially, the German CIT system was based on the tax credit method, such that the amount of CIT assessed was credited against the personal income tax of the shareholder, and retained earnings were subject to a higher tax rate than distributed profits (McDonald 2001). Some corporations and income from foreign sources benefited from reduced statutory CIT rates.

In 2001, the Tax Relief Act eliminated the imputation system in favour of the half-income method. Since then the tax rate on corporate income has been uniform across corporations and independent of the appropriation of profits. According to the half-income method, CIT is definite, and half of the dividends are subjected to personal income tax.<sup>22</sup> Besides the change in CIT system, the reform significantly lowered the statutory CIT rate from 45% (in 1998) to 25% for the remaining period of our sample. In return, the reform broadened the tax base by lowering depreciation allowances, by introducing a requirement to reinstate original values, and by cutting the use of tax loss carry-backs.

In 2004, the Tax Preference Reduction Act introduced a cap on the use of tax loss carry-forwards. Under this so-called minimum taxation, taxable income up to an amount of 1 million euros can be fully offset by tax losses carried forward. Any taxable income exceeding this amount can only be partly offset; 40% of the taxable income is immediately taxed.

In addition to the CIT, corporations are liable to the local business tax at a rate that varies across municipalities (for details, see Fuest et al. 2012, Fossen and Bach 2008). Because there was hardly any change in the local business tax law in our observation period and because municipality specific rates have been surprisingly stable over time, we abstract from the local business tax in our analysis. In the estimations, any difference in the level of the local business tax burden across industry-region groups is absorbed by industry-region group fixed effects. We also do not include the solidarity surcharge, which is a proportional surcharge on the CIT assessed. As the rate of the surcharge did not vary across industry-region groups or over time between 1998 and 2006, its omission should not influence our results.

## **5.2 Exogenous Variation in the ATR Induced by the Tax Reforms**

The Tax Relief Act and the Tax Preference Reduction Act described above provide exogenous variation in the CIT burden. There are several reasons why the two reforms did not affect corporations equally, introducing substantial variation in the changes of the ATR across industry-region groups.

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<sup>22</sup> We cannot include personal income taxes in our analysis as we do not have the information about a corporation's shareholders (such as their participation quotas and their income from other sources) that is necessary for calculating marginal personal income tax rates.

1. At the beginning of our observation period, several corporations and income from foreign sources were eligible for reduced statutory CIT rates; a uniform tax rate has been applied since 2001. This led to uneven changes in the statutory CIT rate and in the ATR, depending on initial rates. Initial statutory CIT rates were equal to 22.5% for operators of merchant ships in international waters and 42% for mutual insurance societies, private foundations, and business enterprises of public corporations. Foreign source income benefitted from a reduced statutory CIT rate of 25%. The Tax Relief Act abolished any preferential treatment of these corporations and sources of income but instead applied a uniform tax rate of 25%.
2. The tax reduction caused by the Tax Relief Act was dependent on a corporation's profit distribution. Under the tax credit method initially in place, the statutory CIT rate differed between retained and distributed earnings. In 1998, the statutory tax rate was 45% (1999 and 2000: 40%) for retained and 30% for distributed profits. Thus, the shift to a uniform tax rate more strongly relieved corporations retaining their earnings, compared to corporations distributing profits.
3. Some corporations experienced a belated drop in their statutory CIT rate as they were not eligible for lower tax rates until 2002. These corporations had a fiscal year different from the calendar year and were only taxed under the half-income method in 2002; in 2001, the tax credit method and a tax rate of 40% (30%) for retained (distributed) profits applied. In turn, these corporations saw their tax rates changed starting in 2002.
4. The change in the ATR does not only depend on the change in the statutory CIT rate but also on changes to the CIT base, adversely affecting some but not all corporations. For example, corporations that placed large real investments in pre- and post-tax reform years saw their after-reform tax base broadened because of lower depreciation allowances for newly acquired goods, compared with pre-reform years. Similarly, the requirement to reinstate original values and restrictions on the use of tax loss carry-backs, both introduced by the Tax Relief Act, lead to additional variation in the change of the ATR.
5. Corporations which offset their profits against losses from other periods did not pay any CIT and thus their CIT rate remained unaffected by the Tax Relief Act. It is important to note that firms cannot decide upon whether and when to use tax losses carried forward. Existing tax loss carry-forwards must be fully offset against current profits.
6. The minimum taxation introduced in 2004 provides additional variation in the change of the statutory CIT rate and the ATR that firms face.

Because of these items, the two tax reforms affected firms differently, as pertains to the effective reduction of their CIT burden and to the point in time in which the tax reforms took effect.

The variation in the change of individual firm's tax burdens leads to substantial variation in the change of the ATR across industry-region groups, which we will pick up to identify CIT incidence.

### 5.3 Empirical Model

To estimate the direct incidence of the CIT on labour, we proceed in two steps. First, we estimate the effect of the ATR on the bargained wage rate, adapting the empirical literature on wage determination (Section 5.3.1). Second, we analyse whether tax-related changes in the price of capital and labour feedback on employment by estimating a tax augmented employment equation (Section 0). Our main innovation is to disentangle tax effects on the price (wage rate) and quantity (employment) of labour. Instead of making the strong assumption that total labour demand is unchanged after a corporate tax reform, we also investigate whether firms decide to hire or fire employees due to a CIT reform.

#### 5.3.1 Tax Effects on Wages

To investigate the role of the CIT on bargained wage rates, we estimate a tax augmented Mincer wage equation at the industry-region level (eq. (5)). Using industry-region level data accommodates the wage bargaining process described in Section 2. Our dependent variable is the natural logarithm of the median gross hourly wage rate,  $w$ . The independent variables include variables controlling for observed and unobserved heterogeneity across industry-region groups and the ATR as the variable of interest.

$$\ln(w_{g,t}) = \alpha + \beta_1(d_{g,t=o+1} \times ATR_{g,t-1}) + \beta_2(d_{t=o+2} \times ATR_{g,t-2}) + \beta_3(d_{t=o+3} \times ATR_{g,t-3}) + \phi' x_{g,t} + \sum_{t=1}^{T-1} \tau' year_t + \eta_g + u_{g,t} \quad (5)$$

To account for observed heterogeneity in the workforce across industry-region groups, we include a vector of control variables  $x_{g,t}$ . The vector of controls shows the average characteristics of the workforce in an industry-region group  $g$  at time  $t$  and includes average age, average age squared, share of women, share of foreigners, and share of workers employed full-time.

Year fixed effects ( $year_t$ ) are included to absorb common time trends and to cover the outside option of the workers. Following the literature, we assume that workers receive the level of utility of an unemployed person if employers and worker representatives do not reach an agreement. During our observation period, the unemployment insurance replacement rate was equal to 60% and constant across industries.<sup>23</sup>

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<sup>23</sup> The replacement rate is 67% for individuals with children. Because we do not have information about the family status of employees, we ignore this small difference in the outside option. As there is no evidence that suggests that people have children in one industry but not in another, this neglect should not bias our results.

Differencing solves the problem of unobserved heterogeneity by removing the group fixed effect,  $\eta_g$ . It also purges potential differences in the bargaining power of unions<sup>24</sup> and differences in the outside option of employers across groups.<sup>25</sup> Because tax return data is observed at intervals of three years only (see Section 0), we do not consider year-to-year changes in our data set but use longer differences over time. More precisely, we calculate the change in the dependent variable as  $\Delta y_{i,t} = y_{i,t} - y_{i,t-3}$  and the change in each explanatory variable as  $\Delta x_{i,t} = x_{i,t} - x_{i,t-3}$ . Because the years, for which tax return data is available, coincide with the years in which the tax law reforms became effective, using longer differences still allows us to capture the variation in ATR.

Wage rates are negotiated based on past after-tax quasi-rents, with two implications for our specification. First, in our baseline regression, we include the ATR from the previous year instead of the contemporaneous tax variable. Second, it might take some time for taxes to fully unfold their effect on the wage rate. Labour market information is available for each year between 1999 and 2006 and tax information is observed in all years in which major changes in the ATR became effective (2001 and 2004). We can thus allow the change in ATR occurring in these reform years to affect future changes in wage rates with a lag. To identify the gradual effect of changes in the ATR on changes in wage rates, we interact the ATR with a set of three binary variables, which indicate the amount of time elapsed after the tax reform had become effective. In the year following a tax reform  $r$ , the dummy variable  $d_{g,t=r+1}$  equals 1, otherwise it is equal to 0; analogously,  $d_{g,t=r+2}$  ( $d_{g,t=r+3}$ ) is equal to 1 in the second (third) year after the reform took place and 0 otherwise.<sup>26</sup> In using this specification, we assume that the wage rate effects of the two tax reforms were underlying the same dynamics. That is, the effect of the change in ATR on the change in wage rates in the year following the reform is assumed to be the same for the Tax Relief Act and for the Tax Preference Reduction Act. The same needs to apply for the tax effects in the second and the third post-reform years. Since there is no reason to suspect the two reforms of differing in terms of their dynamics, we allow for sluggish response of negotiated wage rates to the ATR as indicated in eq. (5).

Note that macroeconomic shocks may produce correlation between wage rates paid by an industry-region group and the group's average level of pre-tax profits, also determining the ATR.

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<sup>24</sup> Because of the relative short time span covered by our data set, bargaining power should be comparatively inert (see also OECD 2004). Yet, if it varied over time, it is part of the error term. Even then, our results remain unbiased, since there is no reason to assume that (unobserved) bargaining power correlates with our instrument for the tax variable.

<sup>25</sup> The employers' outside options matter for the Nash bargaining outcome. In the labour literature it is standard to assume that firms get zero profit if wage bargaining remains without mutual consent. Our specification is more flexible and also accommodates outside options larger than zero, as long as they are time invariant.

<sup>26</sup> Expressed in the longer differences used in our regressions, we estimate the gradual effect of  $(ATR_{2001} - ATR_{1998})$  on  $(\text{wage rate}_{2002} - \text{wage rate}_{1999})$ ,  $(\text{wage rate}_{2003} - \text{wage rate}_{2000})$ , and  $(\text{wage rate}_{2004} - \text{wage rate}_{2001})$ . Correspondingly, we estimate the gradual effect of  $(ATR_{2004} - ATR_{2001})$  on  $(\text{wage rate}_{2005} - \text{wage rate}_{2002})$  and  $(\text{wage rate}_{2006} - \text{wage rate}_{2003})$ .

Because of the potential endogeneity of the ATR, we instrument this term by a counterfactual ATR, exogenous to an industry-region group. This counterfactual ATR is constructed following the method proposed by Gruber and Saez (2002): First, all firm-specific, profit-related components of the 1998 cross-section are aged to match aggregate values from 2001 (2004) (see Online Appendix D2). Then we simulate the counterfactual CIT assessed and counterfactual NPBL for each firm using the microsimulation model BizTax (see Online Appendix D1), based on the CIT law 2001 (2004). Finally, we use these variables to calculate the counterfactual ATR at the industry-region level, as described in eq. (4).

An instrumental variable estimation of eq. (5) yields the semi-elasticity of the wage rate with respect to the ATR ( $\sum\beta$ ). Standard errors of the semi-elasticity are calculated using the delta method.  $\alpha$  is a constant, and  $\phi$  and  $\tau$  are column vectors of regression coefficients.  $u_{g,t}$  is an error term for each group, which may or may not be serially correlated.

In some specifications, we additionally include the average number of employees in each group as an explanatory variable, holding the level of employment fixed. As discussed in the following subsection, we then separately estimate the repercussions of the negotiated wage rate on employment levels. Because unobserved shocks, e.g., to output, might affect both employment and the wage rate, we treat the employment variable in the wage equation as endogenous. We instrument employment by the fourth lag of the share of low-skilled workers, as employment is found to be particularly volatile for them (see e.g., Steiner and Wagner 1998, Card and Blank 2002; OECD 2009).

Before coming to our employment equation, let us briefly comment on a couple of robustness checks which are discussed more thoroughly in Section 6.1. We run sensitivity checks on our dynamic specification by allowing for contemporaneous effects of the ATR and by including the lagged dependent variable (instrumented by the lagged share of low-skilled workers when indicated). In other specifications we check the robustness of our estimates towards the inclusion of capital and sales (instrumented with their lags when indicated), precluding changes in production technology or in output to impair our wage bargaining results. Changes in the determinants of pre-tax profits are related to indirect incidence, which we do not attempt to estimate.

### 5.3.2 Tax Effects on Employment

Next, we discuss the effects of the CIT on employment. Our dependent variable is the natural logarithm of the average number of employees in group  $g$  at time  $t$ ,  $L^d$ . The employment equation includes the standard Mincer control variables ( $x_{g,t}$ ) discussed in the previous section. Again, time dummies ( $year_t$ ) purge any time trend that is common to all industry-region groups from our regression. To capture differential employment trends in East and West Germany, we additionally

include a dummy for East Germany (*east*) and its interactions with the year dummies.<sup>27</sup> We estimate the following equation:

$$\ln(L_{g,t}^d) = \delta + \lambda \ln(w_{g,t}) + \varphi' x_{g,t} + \pi \times east + \sum_{t=1}^{T-1} \tau' year_t + \sum_{t=1}^{T-1} \theta' year_t \times east + \nu_g + e_{g,t}, \quad (6)$$

where  $\delta$  and  $\pi$  are constants,  $\varphi$ ,  $\tau$  and  $\theta$  are column vectors of regression coefficients, and  $e_{g,t}$  is an error term for each group, which may or may not be serially correlated. To account for unobserved heterogeneity across industry-region groups and to eliminate group fixed effects  $\nu_g$ , we estimate the equation in first-differences. We include the hourly wage rate in the equation to assess the wage elasticity of employment,  $\lambda$ . Such change in employment stems from a movement along the labour demand curve. Because of potential endogeneity of the contemporaneous wage rate, we instrument this term using the second lag of real wages, first differences of the third lag of real wages, and first differences of the lagged fractions of education as instrumental variables.

In a robustness check, we no longer assume capital stock to be fixed, but allow capital to adjust to tax-related changes in its user cost. To do so, we include the user cost of capital as an additional regressor. Due to a change in the price of capital, the labour demand curve can either be shifted out- or inwards, depending on the relative size of the scale and the substitution effects. When policy makers call for cuts in corporate tax rates in order to foster capital formation and to spur employment, they assume that the scale effect dominates. That is, they presume that lower corporate taxes lead to higher levels of employment overall. An outwards (inwards) shift would be reflected by a negative (positive) semi-elasticity of employment with respect to the user cost of capital. In our first-differenced equation, we instrument first-differences of the user cost of capital (UCC) variable with the third lag of its level to account for potential endogeneity.

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<sup>27</sup> We also tested for a differential time trend in the wage equation but could not reject the hypothesis that the time trend was equal in East and West Germany. For this reason, we only allow for an East Germany trend in the employment equation.

## 6 Estimation Results

In Section 6.1 we estimate the effect of the average CIT burden on wage rates. Then, in Section 0, we analyse the impact of tax-related changes in wage rates on employment. Finally, we explore the implications of our estimates for CIT incidence in Section 6.3.

### 6.1 Results on Tax-Related Wage Effects

Table 2 presents results for the effect of the ATR on wage rates, using different specifications based on eq. (5). All specifications include time dummies and account for industry-region group fixed effects. Estimating the wage equation in differences also eliminates potential differences in the bargaining power of unions across industry-region groups.

We employ the method of two stage least squares (2SLS) in all estimations and instrument the ATR with its simulated counterfactual to obtain consistent estimates of the tax (semi-)elasticity of the wage rate.<sup>28</sup> The underidentification test (Angrist and Pischke 2009) and calculations of the partial  $R^2$  of excluded instruments (Shea 1997, Godfrey 1999) show that the counterfactual ATRs are highly correlated with the actual ATRs. As the instruments are clearly relevant, our 2SLS estimations are not impaired by the well-known weak instrument problem or by underidentification. We present first-stage results of our baseline specification in Online Appendix E; first-stage results for all further specifications are available from the authors upon request.

All reported standard errors are robust to serial correlation and heteroskedasticity. We use the delta method to derive standard errors for the estimated long-run semi-elasticities of the wage rate with respect to the ATR; the standard errors are very similar if they are computed with bootstrapping methods (unreported results). To turn the estimated semi-elasticities into estimates of the tax elasticity of the wage rate, we evaluate semi-elasticities at the average ATR of 1998 (equal to 0.115).

Column (1) reports the results obtained by regressing the log of the wage rate on past levels of the ATR, without further control variables. There is no allowance for changes in the composition of the workforce over time, although group fixed effects take time-invariant differences in the workforce across groups away. Our baseline specification in column (2) controls for the average characteristics of the workforce, including average age and share of full-time employees. The estimated coefficients on the control variables all show the expected signs. The specification yields an estimate of the long-run semi-elasticity of the wage rate with respect to the ATR of -1.639, which is equal to a tax elasticity of the wage rate of -0.188 ( $p$ -value:  $< 0.001$ ). The baseline

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<sup>28</sup> A standard Hausman test on endogeneity, in which we compare the OLS estimates with the 2SLS regression from column (1) in Table 2, indicates that ATR is endogenous in the wage regression; the  $\chi^2$  test statistic equals 25.06 ( $p = 0.001$ ). We also carried out the test based on robust standard errors as proposed by Cameron and Trivedi (2009, p.429). The  $\chi^2$  test statistic equals 23.15 ( $p < 0.001$ ) and rejects exogeneity of the ATR just as much.



elasticity estimate implies that a reduction in the ATR by 1 percent increases wage rates by about 0.188 percent.

< Table 2 about here >

We subject the results from our baseline estimation to several robustness checks. First, we allow the ATR to immediately affect wage rates, as opposed to imposing a one-year time lag. Including the contemporaneous ATR in column (3) yields a semi-elasticity of -1.646 (elasticity: -0.189), which is not statistically different from our baseline results in column (2) at any conventional significance level.

Second, we give tax effects more time to unfold as wages might be sticky. All specifications presented thus far share the underlying assumption that tax effects fully unfold within the first three years. Yet, wages might be sticky due to multi-year bargaining agreements which are quite common, especially in the manufacturing sector of the German economy. Including the lagged dependent variable into the baseline specification gives wage rates more time to adjust to changes in the ATR. Column (4) reports regression results that are found if lagged wage rates are assumed to be exogenous; in column (5), we instrument the lagged dependent variable by the share of low-skilled workers, lagged by four periods.<sup>29</sup> Adding the lagged dependent variable, whether it is considered exogenous or endogenous, slightly reduces the point estimate of the estimated semi-elasticity but increases its estimated standard error. We cannot reject the null hypotheses that the semi-elasticities are equal to our baseline estimate.

Third, we condition tax effects on sales to preclude changes in output to impair our tax-related wage bargaining results. Information on sales is available for 847 of our 856 groups. As mentioned in Section 0, our sales variable does not include exports and is, thus, an imprecise measure of output. As long as export shares remain unchanged in the observation period, this measurement error is time invariant and should be accounted for by the group fixed effects. In column (6) we assume potential measurement error in output to be time invariant and sales to be uncorrelated with unobserved shocks to the wage rate. This allows us to treat sales as an exogenous variable. In column (7) we remove this assumption and instrument current sales by its fourth lag. The sales coefficient has the expected positive sign in both specifications and is significantly larger if the sales variable is treated as endogenous (0.059 versus 0.019). However, including sales does not significantly change the estimate of the tax elasticity of the wage rate.

Fourth, we include capital so as to avoid changes to the second production factor confounding our estimation results. Adding capital in column (8) hardly affects our estimate of the tax elasticity of the wage rate. In column (9) we jointly include capital and sales to check the robustness of our

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<sup>29</sup> The partial  $R^2$  for the lagged share of low-skilled workers as an instrument is equal to 0.25.

estimates towards changes in both production technology and output, as determinants of pre-tax profits. These determinants of pre-tax profits are related to indirect incidence, which we do not attempt to estimate. Conditioning on capital and sales has little impact on the estimated coefficients and standard errors.

In summary, the baseline results shown in column (2) of Table 2 prove to be very robust regarding the sensitivity checks discussed above. Below, we use the baseline specification to discuss the role of employment in the determination of wage rates.

Our baseline specification resembles the models used in previous literature in that it does not allow us to disentangle tax effects on the price of labour and on the quantity of labour demanded. Even worse, the estimates of the tax variables are possibly confounded as employers might adjust their work force once wage rates are set. A simple wage equation, thus, potentially suffers from an omitted variable bias, which is likely to upwards bias the estimate of the tax elasticity of the wage rate.<sup>30</sup> The institutional background discussed earlier suggests that worker representatives negotiated inefficiently high wage rates during our observation period, making responses in employment very likely. That is, employers might have compensated the increase in wage rates paid by reducing their number of employees. Merely focussing on wage determination thus overestimates the share of the CIT burden borne by labour.

In our incidence analysis, we take a broader view and additionally account for tax effects on the quantity of labour demanded. To this end, we include employment as a regressor in the wage equation. This allows us to estimate the tax elasticity of the wage rate, holding employment fixed. In the following section, we then analyse to what extent tax-related price changes of labour affect the quantity of labour demanded.

Adding the natural log of the number of employees to our baseline specification yields a larger estimate of the tax elasticity of the wage rate (column (10)). This is consistent with a potential upwards bias in the estimate obtained from simple wage equations omitting employment. The semi-elasticity of the wage rate with respect to the ATR equal to  $-2.360$  ( $p$ -value:  $< 0.001$ ) corresponds to an elasticity estimate of  $-0.271$ .

## 6.2 Results on Tax-Related Employment Effects

Table 3 shows by how much employers change their workforce in response to a tax-related change in prices. The results are based on the employment equation (eq. (6)), as described in Section 0. We account for industry-region group fixed effects by first-differencing the data. Time

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<sup>30</sup> The direction of the bias depends on the sign of the (omitted) employment coefficient and on whether the correlation between employment and the ATR is positive or negative. It is reasonable to assume that both the employment coefficient and the correlation between employment and the tax burden are negative, leading to an upward bias of the ATR estimates. Note that the bias still persists in IV estimations if (lagged tax) instruments happen to be correlated with employment.

dummies are included. To capture differential employment trends in East and West Germany, we add a dummy for East Germany and its interaction terms with all year dummies. In the 2SLS estimation, we use the second lag of real wages, first differences of the third lag of real wages, and first differences of the lagged fractions of education as instrumental variables for the most likely endogenous contemporaneous wage rate. In the specification including the user cost of capital, the third lag of its level is used as an instrument. The Sargan test and the partial  $R^2$  Shea, presented in Table 3, indicate that our instrumental variables are valid and relevant. All reported standard errors are robust to serial correlation and heteroskedasticity.

< Table 3 about here >

First, we estimate short run tax effects on employment, assuming capital to be fixed. If so, first-differencing purges any differences in capital stock across industry-region groups from our employment equation. Turning to the coefficient estimates in column (1), we find that employers partly compensate an increase in negotiated wage rates by reducing their workforce. The wage rate elasticity of labour demand equal to -0.623 ( $p$ -value: 0.020) implies that an increase in the wage rate by 1 percent reduces the number of the employed by 0.623 percent.

Second, we allow capital to adjust by inclusion of the user cost of capital. Column (2) presents evidence for both a movement along the labour demand curve induced by greater wage rates and a tax-related shift of it. In terms of movement along the demand curve, we find a wage rate elasticity of labour demand equal to -0.756 ( $p$ -value: 0.003). As regards the shift of the demand curve, the estimation yields an estimate of the labour demand elasticity with respect to the UCC of -0.989 ( $p$ -value: 0.001). As discussed in Section 0, the net effect of the increase in capital stock on employment depends on the relative size of the scale and the substitution effects. In our estimation we find that a cut in the price of capital, associated with larger capital stock, leads to an increase in employment. We therefore conclude that the scale effect dominates the substitution effect.

### 6.3 Evaluation of CIT Incidence and Employment

Finally, we explore the implications of our estimates for CIT incidence and for employment. Our first measure of direct CIT incidence provides for both margins of the corporate wage bill – wage rates and employment. As we will discuss, employment responses are important both quantitatively and for correct calculation of direct incidence. The second measure provided is comparable to results in previous literature in that it exclusively focuses on wage rate responses.

Our first measure of direct CIT incidence is based on tax-related changes in both wage rates and employment. The results are calculated based on the tax elasticity of the wage rate given in eq. (3), which is reproduced for ease of reference.

$$\eta_{wage\ bill,\tau} = \left[ 1 + \eta_{L^d,w} \right] \times \eta_{w,ATR} \times \eta_{ATR,\tau} \quad (3)$$

As discussed in Section 3.3, eq. (3) refers to the net effect of wage bargaining on the corporate wage bill.

We need to plug the elasticities estimated above into eq. (3) in order to calculate the elasticity of the corporate wage bill with respect to the statutory CIT rate. The tax elasticity of the wage rate, holding employment fixed, is -0.271 (column (10) in Table 2). In Table 3, we estimated the wage elasticity of employment under two different scenarios concerning the adaptability of capital stock, which was assumed to be either fixed or variable. With fixed (variable) capital stock, we find a wage elasticity of employment of -0.623 (-0.756). Finally, we calculate the elasticity of the ATR with respect to the statutory CIT rate, which is equal to 0.324.<sup>31</sup> Based on these elasticity estimates we obtain the tax elasticity of the corporate wage bill, equal to -0.033 (with fixed capital) and -0.021 (with variable capital stock).

< Table 4 about here >

To identify CIT incidence, it is useful to contrast the loss in CIT revenue, caused by a cut in the statutory CIT rate, with the associated increase in the corporate wage bill. Calculations of CIT incidence using the estimated elasticities from above are presented in Table 4. We start by assuming capital stock to be fixed (and purged from the equation by first-differencing). Based on the elasticity of the corporate wage bill of -0.033, we find that an exogenous €1 decrease in the CIT burden leads to a 29 cents increase in the corporate wage bill. Our approach allows us to split the incidence result into its theoretical components, namely the wage increase and the employment effects caused by a movement along the labour demand curve. Past a tax reduction by € 1, we see wage rates rise, leading to notional increase in the corporate wage bill by 77 cents. Yet, employers exercise their right to lay off workers in response to the wage rates set. Such movement along the labour demand curve results in a theoretical reduction in the corporate wage bill by 48 cents. Combining the intensive and the extensive margins of the corporate wage bill suggests that workers share in the tax (reduction) through wage bargaining but bear thereby no more than a fourth of the CIT burden.

In the long run, capital is likely to adjust to tax-related changes in the price of capital. In column (2) of Table 3, we allow capital to vary over time. Based on these estimates and following the same incidence calculation as above, the results indicate that direct CIT incidence is 0.19: that is, wage bargaining after an exogenous decrease of € 1 in the CIT burden would increase the corporate wage bill by 19 cents in the long run. Thus, workers share in reductions of the CIT burden—yet, direct incidence is small and confined to 0.19–0.29.

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<sup>31</sup> The tax elasticity of the ATR is calculated as the average of  $[(ATR_{1998}-ATR_{2001})/ATR_{1998}]_g/[(\tau_{1998}-\tau_{2001})/\tau_{1998}]_g$  across all industry-region groups.

< Table 5 about here >

What is the total *employment* effect of a cut in the statutory CIT rate? To answer this question, we consider a cut in the statutory CIT rate by 40% (as introduced by the Tax Relief Act) and calculate the change in the number of the employed that such a reduction of the statutory CIT rate would entail. To put the (negative) employment effect caused by wage bargaining into perspective, we also consider (positive) employment effects due to greater capital stock.<sup>32</sup> As laid out in Table 5, wage bargaining has the expected negative effect on employment as wage rates are set at inefficiently high levels (-450 410 workers). On the other hand, an additional 559 872 workers are employed because of the fostered capital stock after a tax-related decrease in the user cost of capital. In total, a 40% reduction of the statutory CIT rate leads to a net increase of employment (+ 99 511), which is in accordance with conventional wisdom.

Our second measure of direct CIT incidence is obtained under the assumption that employment remains constant. Such a measure of CIT incidence was used in prior literature. We use the baseline wage rate specification without employment (Table 2, column (2) and  $\eta_{L^d,w} \equiv 0$ ) to calculate the tax elasticity of the corporate wage bill, based on eq. (3). Both the elasticity and the incidence estimates are presented in the last two rows of Table 4. Assuming employment to be constant generates estimates of the tax elasticity of the corporate wage bill of -0.061 and of CIT incidence of 0.537; that is, a reduction in the CIT worth € 1 would increase the corporate wage bill by 54 cents. This estimate is surprisingly similar to the results that Arulampalam et al. (2012) obtained on a very different data set. Neglecting any employment responses, Arulampalam et al. arrive at the conclusion that direct corporate incidence is between 0.637 and 0.493 in the short and long run, respectively. Comparing the estimate obtained under the assumption of fixed employment to our preferred estimates discussed above shows that merely focussing on wages leads to an overestimation of direct tax incidence.

## 7 Conclusion

Taxes on corporate income impact the average quasi-rent in an industry and the industry's wage bill. Wages being partly determined by workers sharing in quasi-rents leads to direct incidence: given pre-tax profits, a lower tax burden directly increases the after-tax quasi-rent over which firms and workers can bargain. Wage bargaining thus introduces a direct channel by which taxation affects the burden borne by labour.

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<sup>32</sup> The calculations are described in more detail in Table 5. Note that the user cost of capital might not only directly affect labour demanded but also wage rates paid. In a robustness check we therefor added the user cost of capital as an explanatory variable to the wage estimation from column (10) of Table 2. To account for endogeneity of the user cost of capital variable we used its fourth lag as an instrument. Results are unchanged (semi-elasticity of the wage rate with respect to the ATR of -2.406, corresponding tax elasticity of the wage rate of -0.276).

This paper contributes to the small literature on direct incidence. Particularly, we empirically investigate the size of direct corporate income tax incidence, taking employment effects into account for the first time. Negative employment effects arise if worker representatives have a strong preference for higher wages while bargaining, rather than for employment. Then, the wage rate increase, negotiated after a tax cut, is inefficiently high in price. In a right-to-manage setting, such undue increase in wage rates leads to lower levels of employment.<sup>33</sup> While wage rates are subject to negotiation, firms thereafter unilaterally choose employment for given wage rates. In this paper, we argue that the right-to-manage model fits the German case during our observation period fairly well. Employment responses are thus expected to be an important determinant of the overall wage bargaining outcome. We estimate direct incidence using an industry-region level panel data set covering all corporations in Germany between 1998 and 2006. Identification comes from two major tax reforms, which introduce exogenous variation in the change of the corporate income tax burden across industries in our observation period.

Our results show that it is crucial to take into account wage-related employment effects when calculating direct incidence. We find that workers share in reductions of the CIT burden – yet, direct incidence is small and confined to 0.19–0.29. That is, the net effect of wage bargaining on the corporate wage bill, after an exogenous € 1 decrease in the CIT burden, is as little as 19 to 29 cents. This is about half of the effect obtained in prior literature under the assumption that employment remained constant. Reproducing these estimates and comparing direct incidence with and without employment responses confirms that a mere focus on wages leads to an overestimation of direct tax incidence.

In this paper, we investigated how tax-related wage bargaining affected the corporate wage bill (an aggregate measure of labour market outcomes). Necessarily, the aggregate measure clouds its very heterogeneous effects on individual workers: some receiving higher wage rates, others being laid off. It is left for future research to analyse the distributional effects brought about by tax-related wage bargaining.

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<sup>33</sup> Calculating the *overall* employment effect of a cut in the statutory CIT rate shows that a tax reduction leads to a net *increase* of employment: the tax cut fosters capital stock and output and thereby enhances employment more strongly than employment is impaired by wage bargaining.

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## Tables

**Table 1a: Descriptive statistics of labour variables**

	1999	2000	2001	2002	2003	2004	2005	2006
Hourly wage rate in euros (median)	11.49 <i>3.55</i>	11.41 <i>3.67</i>	11.69 <i>3.8</i>	11.97 <i>3.92</i>	12.19 <i>4.07</i>	12.02 <i>4.15</i>	11.94 <i>4.27</i>	11.97 <i>4.38</i>
Employment (number of employees)	34,896 <i>97,171</i>	37,200 <i>101,128</i>	37,289 <i>100,986</i>	36,540 <i>100,220</i>	36,029 <i>98,890</i>	36,805 <i>99,922</i>	36,257 <i>97,382</i>	36,736 <i>98,166</i>
Age (average)	38.89 <i>2.60</i>	39.21 <i>2.69</i>	39.43 <i>2.73</i>	39.76 <i>2.72</i>	40.01 <i>2.69</i>	40.28 <i>2.66</i>	40.58 <i>2.65</i>	40.73 <i>2.58</i>
Share of women (average)	0.41 <i>0.21</i>	0.42 <i>0.21</i>	0.41 <i>0.21</i>	0.41 <i>0.21</i>	0.41 <i>0.21</i>	0.42 <i>0.20</i>	0.41 <i>0.20</i>	0.41 <i>0.20</i>
Share of foreigners (average)	0.05 <i>0.06</i>	0.05 <i>0.05</i>	0.05 <i>0.05</i>	0.05 <i>0.05</i>	0.05 <i>0.05</i>	0.05 <i>0.05</i>	0.05 <i>0.05</i>	0.05 <i>0.05</i>
Share of full-time employed (average)	0.76 <i>0.22</i>	0.75 <i>0.19</i>	0.75 <i>0.19</i>	0.75 <i>0.18</i>	0.74 <i>0.19</i>	0.73 <i>0.17</i>	0.72 <i>0.17</i>	0.72 <i>0.17</i>
Number of groups	856							

*Notes:* All information is at the industry-region level of our data set and in prices from 2000. Standard deviations of variables are printed in italics just below. Data for the marginally employed were imputed for the first quarter of 1999 (see Online Appendix C3).

*Source:* Own calculations, based on aggregated data from the historical files for the years 1999 to 2006, provided by the Institute for Employment Research.

**Table 1b: Descriptive statistics of corporate tax return variables**

	1998	1999	2000	2001	2002	2003	2004	2005	2006
ATR (average)	0.115 <i>0.041</i>	- -	- -	0.075 <i>0.025</i>	- -	- -	0.077 <i>0.025</i>	- -	- -
Potential tax loss carry-forward (average in euros)	686,723 <i>2,284,864</i>	- -	- -	798,393 <i>3,839,518</i>	- -	- -	1,225,920 <i>7,102,556</i>	- -	- -
Share of corporations with tax loss carry-forward at the beginning of the year (average)	0.547 <i>0.086</i>	- -	- -	0.559 <i>0.090</i>	- -	- -	0.578 <i>0.076</i>	- -	- -
Sales (average in 1,000 euros)	284,452 <i>690,148</i>	299,244 <i>725,146</i>	322,385 <i>808,069</i>	349,812 <i>932,492</i>	321,210 <i>749,732</i>	328,209 <i>802,732</i>	331,889 <i>792,904</i>	333,290 <i>745,747</i>	373,642 <i>826,938</i>
Total capital (average in euros)	4,357,581 <i>27,755,155</i>	4,198,966 <i>23,666,623</i>	4,226,983 <i>21,305,285</i>	4,492,553 <i>20,693,022</i>	4,334,942 <i>19,307,501</i>	4,418,989 <i>20,767,076</i>	4,753,756 <i>25,068,799</i>	5,418,002 <i>36,046,398</i>	6,711,602 <i>62,520,030</i>
User cost of capital (average)	0.163 <i>(0.028)</i>	0.165 <i>(0.028)</i>	0.181 <i>(0.030)</i>	0.168 <i>(0.029)</i>	0.160 <i>(0.025)</i>	0.148 <i>(0.025)</i>	0.141 <i>(0.024)</i>	0.140 <i>(0.024)</i>	0.146 <i>(0.024)</i>
Number of groups					856				
Number of corporations within each group	855.635 <i>2,221.464</i>	- -	- -	934.640 <i>2,598.200</i>	- -	- -	992.508 <i>3,106.634</i>	- -	- -
Underlying number of corporations									
All corporations	732,424	-	-	800,052	-	-	849,587	-	-
Corporations with tax loss carry-forward at the beginning of the year	369,324	-	-	405,460	-	-	438,310	-	-

*Notes:* All information is at the industry-region level of our data set and in prices from 2000. Standard deviations of variables are in printed in italics just below.

*Source:* Own calculations, based on the corporate income tax statistics 1998, 2001, and 2004, the value added tax statistics 1998 to 2006, and the local business tax statistics 1998, 2001, and 2004, provided by the German Federal Statistical Office and the Statistical Offices of the Länder.

**Table 2: Semi-elasticity of the hourly wage rate with respect to taxes (2SLS estimation)**

Dependent variable: $\log(\text{wage rate}_{g,t})$	without employment									with empl.
	(1)	(2) base- line	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\text{ATR}_{g,t}$	-	-	-0.682 (0.245)	-	-	-	-	-	-	-
$\text{ATR}_{g,t-1}$	-0.626 (0.189)	-0.544 (0.192)	-0.496 (0.195)	-0.295 (0.171)	-0.207 (0.191)	-0.516 (0.200)	-0.428 (0.225)	-0.499 (0.193)	-0.478 (0.200)	-0.695 (0.255)
$\text{ATR}_{g,t-2}$	-0.514 (0.184)	-0.499 (0.188)	-0.468 (0.185)	-0.242 (0.144)	-0.150 (0.148)	-0.451 (0.188)	-0.323 (0.203)	-0.461 (0.187)	-0.418 (0.187)	-0.754 (0.235)
$\text{ATR}_{g,t-3}$	-0.508 (0.153)	-0.596 (0.144)	-	-0.297 (0.116)	-0.191 (0.137)	-0.571 (0.145)	-0.487 (0.154)	-0.560 (0.143)	-0.538 (0.145)	-0.911 (0.178)
$\text{Log}(\text{wage rate}_{g,t-1})$	-	-	-	0.431 (0.047)	0.585 (0.094)	-	-	-	-	-
$\text{Log}(\text{employment}_{g,t})$	-	-	-	-	-	-	-	-	-	-0.203 (0.044)
$\text{Age}_{g,t}$	-	0.181 (0.037)	0.267 (0.033)	0.087 (0.039)	0.054 (0.040)	0.185 (0.036)	0.187 (0.036)	0.182 (0.037)	0.186 (0.036)	0.183 (0.037)
$\text{Age squared}_{g,t}$	-	-0.002 (0.000)	-0.003 (0.000)	-0.001 (0.000)	-0.000 (0.000)	-0.002 (0.000)	-0.002 (0.000)	-0.002 (0.000)	-0.002 (0.000)	-0.002 (0.001)
$\text{Share of women}_{g,t}$	-	-0.601 (0.098)	-0.641 (0.085)	-0.415 (0.092)	-0.347 (0.101)	-0.577 (0.097)	-0.527 (0.097)	-0.590 (0.099)	-0.569 (0.098)	-0.812 (0.117)
$\text{Share of foreigners}_{g,t}$	-	-0.155 (0.065)	-0.262 (0.069)	-0.080 (0.050)	-0.052 (0.049)	-0.142 (0.063)	-0.117 (0.062)	-0.156 (0.065)	-0.144 (0.063)	0.074 (0.095)
$\text{Share of full-time employed}_{g,t}$	-	0.040 (0.009)	0.069 (0.010)	0.025 (0.008)	0.020 (0.008)	0.037 (0.009)	0.030 (0.010)	0.041 (0.009)	0.038 (0.009)	0.078 (0.022)
$\text{Log}(\text{sales}_{g,t})$	-	-	-	-	-	0.019 (0.003)	0.059 (0.015)	-	0.014 (0.003)	-
$\text{Log}(\text{capital}_{g,t})$	-	-	-	-	-	-	-	0.016 (0.003)	0.018 (0.003)	-
Group fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Time fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Long-run semi-elasticity with respect to the ATR	-1.649 (0.305)	-1.639 (0.308)	-1.646 (0.365)	-1.467 (0.444)	-1.320 (0.643)	-1.538 (0.312)	-1.237 (0.332)	-1.521 (0.311)	-1.433 (0.315)	-2.360 (0.404)
Long-run elasticity with respect to the ATR at the average ATR of 1998	-0.189 (0.035)	-0.188 (0.035)	-0.189 (0.042)	-0.169 (0.051)	-0.152 (0.074)	-0.177 (0.036)	-0.142 (0.038)	-0.175 (0.036)	-0.165 (0.036)	-0.271 (0.046)
Number of observations	4,280	4,280	5,136	4,280	4,280	4,235	4,235	4,280	4,235	4,280

*Notes:* Heteroskedasticity-consistent robust (Huber-White) standard errors are reported in parentheses. Standard errors of the tax semi-elasticity of the wage rate are calculated with the delta method. All specifications include time fixed effects and are estimated in differences, using three-year differences. We use the counterfactual ATR as an instrument for the ATR in all estimations (see text); in columns (5) and (7), we use the fourth lag of the share of low-skilled workers and the fourth lag of sales as instruments for the lagged dependent variable and sales, respectively. Employment in column (10) is instrumented by the fourth lag of the share of low-skilled workers. Information on sales is only available for 847 of our 856 groups.

*Sources:* Own calculations based on aggregated data from the historical files for the years 1999 to 2006, provided by the Institute for Employment Research, and based on the corporate income tax statistics 1998, 2001, and 2004, the local business tax statistics 1998, 2001, and 2004, and the value added tax statistics 1999 to 2006, provided by the German Federal Statistical Office and the Statistical Offices of the Länder.

**Table 3: Tax-related effects on employment (2SLS estimation)**

Dependent variable: $\log(\text{employment}_{g,t})$	Capital fixed (1)	Capital variable (2)
Log(gross hourly wage rate $_{g,t}$ )	-0.623 (0.268)	-0.756 (0.262)
UCC $_{g,t}$	-	-6.071 (1.777)
Age $_{g,t}$	0.456 (0.075)	0.446 (0.076)
Age squared $_{g,t}$	-0.006 (0.008)	-0.006 (0.001)
Share of women $_{g,t}$	-1.531 (0.273)	-1.634 (0.269)
Share of foreigners $_{g,t}$	0.293 (0.108)	0.268 (0.109)
Share of full-time employed $_{g,t}$	0.117 (0.021)	0.119 (0.021)
Group fixed effects	✓	✓
Time fixed effects	✓	✓
Dummy for East Germany	✓	✓
Time dummies $\times$ dummy for East Germany	✓	✓
Long-run elasticity with respect to the UCC at the average UCC of 1998	-	-0.989 (0.290)
Number of observations	4,280	4,280
Sargan test statistic	3.475	4.191
... p-value in $\chi^2$ distribution	0.482	0.381
$R^2$ Shea		
... UCC $_{g,t}$	-	0.167
... Log(grosshourlywage $_{g,t}$ )	0.291	0.131

*Notes:* Heteroskedasticity-consistent robust (Huber-White) standard errors are reported in parentheses. Estimates are based on first-differenced data. We use the second lag of real wages, first differences of the third lag of real wages, and first differences of the lagged fractions of education as instrumental variables for the contemporaneous wage rate. The third lag of the user cost of capital is used as an instrument for the user cost of capital variable.

*Sources:* Own calculations based on aggregated data from the historical files for the years 1999 to 2006, provided by the Institute for Employment Research, and based on the corporate income tax statistics 1998, 2001, and 2004, the local business tax statistics 1998, 2001, and 2004, and the value added tax statistics 1999 to 2006, provided by the German Federal Statistical Office and the Statistical Offices of the Länder.

**Table 4: Estimated CIT incidence**

	Total	Thereof: wage increase	Thereof: change in employment due to a movement along the labour demand curve
	(1)	(2)	(3)
<b><u>Calculations based on preferred estimates</u></b>			
<b>Capital assumed to be fixed:</b>			
Tax elasticity of the corporate wage bill <sup>1)</sup>	- 0.033 (0.018)	- 0.088 (0.014)	+ 0.055 (0.014)
Direct incidence	0.291 (0.160)	0.773 (0.120)	- 0.482 (0.119)
<b>Capital allowed to vary:</b>			
Tax elasticity of the corporate wage bill <sup>2)</sup>	- 0.021 (0.022)	- 0.088 (0.018)	+ 0.067 (0.031)
Direct incidence	0.189 (0.197)	0.773 (0.154)	- 0.584 (0.268)
<b><u>Assuming employment to remain constant</u></b>			
Tax elasticity of the corporate wage bill <sup>3)</sup>	- 0.061 (0.012)	- 0.061 (0.012)	aggregate employment is assumed to remain constant
Incidence estimate that can be compared to prior literature	0.537 (0.106)	0.537 (0.106)	

*Notes:* Elasticity of the corporate wage bill calculated as described in eq. (3). Sub elasticities are obtained by applying the appropriate terms of eq. (3). Incidence estimates are based on pre-reform information from 1998. In 1998, the corporate gross wage bill was € 318.33 bn. The CIT assessed at that time was € 36.28 bn. Tax incidence is calculated by relating the increase in the corporate wage bill caused by a 1% reduction in the statutory tax rate to the respective decrease in the amount of CIT assessed. We follow the convention in the literature and define tax incidence as a positive number if the reduction in CIT assessed leads to an increase in the corporate wage bill. E.g., total direct incidence with fixed capital is given by  $-[(-0.01)*(-0.033)*€ 318.33 \text{ bn.}] / [(-0.01)*€ 36.28 \text{ bn.}] = 0.29$ . Bootstrapped standard errors (100 replications, with replacement) are in parentheses.

<sup>1)</sup> Calculation based on estimates from Table 2, col. (10), and Table 3, col. (1) (see text for details).

<sup>2)</sup> Calculation based on estimates from Table 2, col. (10), and Table 3, col. (2) (see text for details).

<sup>3)</sup> Elasticity calculated with  $\eta_{L,w} \equiv 0$ , using the estimate from Table 2, col. (2) (see text for details).

*Source:* Own calculations, based on estimates in Tables 2 and 3. Information on the corporate gross wage bill is from the National Income and Expenditure Survey, the value added tax statistics, and the German Business Register. Aggregated CIT assessed is from the CIT statistics from the year 1998.

**Table 5: Employment effects caused by a 40% reduction of the statutory CIT rate (as introduced by the Tax Relief Act)**

	<b>Total</b>	Thereof: through wage bargaining	Thereof: through greater capital stock
	(1)	(2)	(3)
<b><math>\eta_{L,w} \equiv 0</math>:</b>			
Tax-related change in full-time equivalents	- 337 428	- 337 428	n.a.
<b><math>\eta_{L,w}</math> as estimated:</b>			
Tax-related change in full-time equivalents	+ 99 511	- 409 463	+ 508 974

*Notes:* Employment response to a 1% reduction of the statutory CIT rate (of the user cost of capital) is calculated as  $(-0.40)\eta_{L,w}\eta_{w,ATR}\eta_{ATR,\tau}N$  ( $(-0.40)\eta_{L,UCC}\eta_{UCC,\tau}N$ ), where  $N$  is the number of the employed (15 375 204 individuals).

*Source:* Own calculations, based on estimates in Tables 2 and 3. Information on employment levels is from the German Business Register from the year 2007.