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The Incidence of Taxation and Regulation in the Labor Market

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Preface

1.1 Motivation

Ronald W. Reagan, never short of a saucy word, once said:

> "Government's view of the economy could be summed up in a few short phrases: If it moves, tax it. If it keeps moving, regulate it. And if it stops moving, subsidize it."

While not all of us share Reagan's pessimistic opinions on government action, the question on where and when the government should act and if so, how best, never ceases to be the topic of heated debate.

Topics in public and labor economics are quite present in public perception, perhaps more so than other fields of economic research. Many people attach values and beliefs beyond simple financial considerations to employment and wages. Labor market policies like minimum wages trigger (political) debates running high on emotions about the value of work and that people should be able "to make a living from their work".

Notwithstanding the topics dominating in the media and non-economic dimensions of public and labor market policy, regulation as much as tax and transfer policy can have many more hidden sides to it. Intentionally or not, taxes and regulations may affect not only those stakeholders mentioned explicitly in the wording of the law but also many others. The concept of incidence captures the question who actually bears the burden of a policy. Harberger (1962) can be regarded as the founding father of

modern incidence analysis that strives to pin down the actual incidence in contrast to the statutory incidence. In the scope of a general equilibrium analysis he showed how a tax levied on capital owners in one sector is born by all capital owners in the economy.

Who does actually bear the burden or the benefits of a policy? And how big is that burden? Answers to these questions are crucial for an optimal policy design but are in many cases not yet settled. This thesis sheds light on the incidence of three dimensions of tax and labor market policy; the effect of a minimum wage on the wage structure, the shifting of the corporate tax burden onto labor, and the impact of taxes and their structure on wages. Methodologically ex-post evaluation and panel data methods in combination with micro-simulation models are used to analyze empirically the relationships at hand.

Several institutional changes in the past twenty years provide opportunities for analysis; the intention to introduce a general minimum wage has been voiced only recently by the conservative party who up till then always had opposed a general minimum wage. Nevertheless even before this articulate change of mind there existed an exception since 1997, when a minimum wage for the main construction sector was introduced.

In 2000 the Schröder government passed the most comprehensive tax reform since WWII (*Steuerreform 2000*). With the aim of advancing economic growth and employment through tax relief for firms and households, major changes to the income and corporate tax system were undertaken. In 2001 imputation system in the assessment of corporate tax was eliminated and the half-income method was introduced. At the same time the corporate tax rate was lowered to 25%. The reform thus significantly altered the tax base and the tax rate at the same time. Changes to the loss-offsetting rules in 2004 induced some more slighter changes. The reform of the personal income tax schedule took place in steps between 2001 and 2006 and reduced marginal tax rates across the board while increasing tax allowances. In 2007 a reform revised the marginal tax rate for top incomes up to 45% again. Part of the *Hartz* reforms from 2003 were relevant to changes in Social Security introducing the so-called *midi jobs* for a less harsh increase of payroll tax when moving beyond marginal employment. Some change of rules and upratings of assessment ceilings increased or shifted the statutory payroll tax load in 2003 and 2005.

In Chapter 2 the introduction of the first sectoral minimum wage in the construction sector is used as a natural experiment to gauge the effect of the regulation on the wage

structure in the sector. Chapter 3 considers the shifting of the corporate tax on labor using the variation in corporate taxes introduced by the reforms in the 2000s. The various changes to the personal income tax and payroll tax outlined above are used in Chapter 4 to analyze the effect of the structure of labor taxes on the wage outcome. Finallly, Chapter 5 concludes and provides an outlook to future avenues of research.

1.2 Contribution and main findings

The very first minimum wage introduced in Germany in 1997 is the focus of the next Chapter. While in many countries minimum wages have been firmly established for decades the conservative and liberal parties in Germany had declined their introduction for fear of employment losses. The construction sector was an exception to this belief as the free movement of labor associated with the Single European Market increased the pressure on the comparatively well-paid main construction trade at a time where business in the sector was declining. In view of lacking institutional protection by laws on the European level the liberal-conservative government passed a minimum wage legislation with the aim of alleviation pressure on construction labor market. The minimum wage was introduced for blue-collar workers in a sub-sector of the construction industry. Based on linked employer-employee official micro data I use this peculiarity to evaluate the reform in a differences-in-differences-in-differences estimation framework using blue-collar workers in neighboring 4-digit-industries and white-collar workers as control groups. While the minimum wage legislation is based on increasing the wages of those below a certain level up to the new threshold, spillovers along the wage distribution may occur and working time may be affected by the MW.

No effect on working time or substitution of workers on the intensive margin is detected. The analysis shows a sizable positive effect at the mean of wages in the treated sub-sectors of East Germany but small and insignificant effects in West Germany. In East Germany it is the impact on mean wages of employees not paid under a collective agreement that is driving the results. The pattern of treatment varies along the wage distribution; while the effect is highest in the lower parts of the distribution reducing inequality, it remains significantly different from zero higher up the wage distribution

where in the spirit of the median voter theory the union member that is decisive for the bargaining strategy is located.

In Chapter 3 the burden of the capital income tax passed onto labor is assessed. Recent empirical evidence shows a negative effect of corporate tax rates on wages, but the size of effects found covers a wide range. Against the backdrop of wage bargaining over economic rents a unique pseudo-panel data set based on the full records of corporate taxation and employee remuneration is used to gauge the extent of shifting. The study furthermore contributes to the literature by shedding light on the overall incidence. Accounting for both, the outcome of the wage bargaining itself and the adjustment of labor demand due to the altered user cost of capital, provides a more complete picture of incidence than so far common in the literature.

Variation in firm-specific average corporate tax rates across firms and time due to the corporate tax reforms is used to identify the impact. The potentially endogenous corporate tax rate is instrumented with the counterfactual tax rate a corporation would have faced in a particular period had it not been subject to the endogenous change of its tax base. This instrument variable is computed in a highly detailed microsimulation model (BizTax) and implemented in the estimation of a panel in first differences to purge fixed effects. Incidence results show that a €1 cut in corporate tax leads to a €0.47 increase in the wage bill when employment adjustments due to changes in the user cost of capital are accounted for. Following the approach conventional in the literature suggests full shifting of the tax burden onto labor and corroborates the claim to properly factor in the changes to labor demand.

Chapter 4 looks at the influence of payroll as much as income tax and the overall tax load on the consumer wage outcome. Motivated by the predictions of a wage bargaining model that progressivity has wage-reducing effects and average tax rates act wage-increasing, the effect of the structure of taxation is analyzed. The comprehensive load of the tax and benefit system is considered to measure the overall burden on the employee side and so avoids the problem of only including social security on the employer side. This is moreover not only a closer mirror of reality but also corresponds better to theories' assumptions. In a microsimulation model (STSM) that closely mimics the intricate tax and transfer system at work in Germany, employees' tax rates are computed under consideration of the household context and income other than labor.

To purge the endogeneity problem of tax variables, tax rates are instrumented with their counterfactual values in case that there had been no endogenous response to tax policy reform. Following wage bargaining theory hypothetical simulated benefits and regional unemployment rates are included in the first differences estimation of the effect of the tax variables on wages.

The model motivating the analysis is rejected but the general prediction of wage-bargaining models of the wage-decreasing effects of marginal tax rates is supported by the empirical results. A closer look at heterogeneity along the wage distribution reveals that progressivity has a differential impact for the lower and the upper half of the wage distribution. In the lower part of the distribution estimation results are suggestive of the predictions of imperfect labor market theories. But in the higher range of the wage distribution wage-increasing effects of progressivity show up.

Chapter 2

Building the minimum wage: Germany's first sectoral minimum wage and its impact on wages and hours in the construction industry

2.1 Introduction

Minimum wages (MWs) have been for a long time and continue to be brought up as a panacea in labor market policy, equality and fairness discussions. MWs are implemented in developed and developing countries alike. The institutional designs range from a nation-wide MW to regional and sector-specific rates. Some countries rely on different levels of pay for younger and older or more and less educated employees. Such great variety of institutional details reveals the manifold opinions and beliefs in societies and governments across the world about the effects of the MW.

Germany introduced its first MW in 1997 as a sector-specific MW in parts of the construction industry. The MW covered blue-collar workers (*gewerbliche Arbeitnehmer*) in substantial parts of the main construction trade with different rates for East and West Germany and was negotiated between organized employers and unions of the industry. Since then sector-specific binding lower floors for wages have been installed in several other sectors such as cleaning and postal services with more sectors to follow. There

is agreement that the MW in the construction sector constituted a breach in till then dominant reservation against MWs by the political establishment.

Despite its seminal importance, it is little evaluated and therefore, "the empirical basis of the debate in Germany is, unfortunately, still very weak" (Fitzenberger, 2009). This can be blamed mainly on the lack of suitable data. König and Möller (2007) find small positive effects of the MW introduction on wages and negatively (slightly positively) employment effects in East (West) Germany using data from the Federal Employment Agency, which do not allow for calculation of hourly wages and a proper distinction of those treated. The results on employment are challenged by Müller (2010), who finds negative employment effects, particularly large for East Germany.

Evidence on wage effects of the MW from the UK reports a significant increase in wages and a compression in the lower part of the wage distribution (Machin and Wilson, 2004; Machin et al., 2003; Dickens and Manning, 2004b). Studies for the US emphasize the role of spillovers and effects of the MW on parts of the wage distribution where it is not binding (Katz and Krueger, 1992; Card and Krueger, 1995; Manning, 2003). The institutional design of the German MW is closely tied to the wage bargaining at the sectoral level in contrast to many other countries' institutions and the MW was introduced as an additional lowest rung to the pay scale in the wage negotiations. For the Spanish setting, which is somewhat more akin to the German case, Dolado et al. (1997) attribute a 6.21% wage gain to the existence of collectively bargained sectoral MWs situated above the national statutory minimum. While the general effect of unions and/or collective agreements on wages is not yet conclusively settled for the German case (Stephan and Gerlach, 2005; Fitzenberger et al., 2008), it remains an open question how the introduction of a lowest wage floor determined through wage bargaining that is binding for all workers in an industry affects average wages and the structure of wages overall.

The aim of this study is to shed light on the following issues: Did the MW truly bite? Was there an average effect on wage growth and was such effect heterogeneous across wage regimes? Are there spillover effects of the MW?

Owing to the initial introduction of the MW to certain sub-sectors of the industry, these questions can be evaluated in the scope of a natural experiment. One of the few data sources in Germany that allows for calculation of hourly wages while offer-

ing enough observations with industry information on the 4-digit level is the German Structure of Earnings Survey (GSES; *Gehalts- und Lohnstrukturerhebung*), a linked employer-employee data set. Based on two cross sections I can properly distinguish between employees that were eligible to the MW and those that were not. Due to the data structure two groups of employees in the construction sector lend themselves naturally as control groups; blue-collar workers in establishments that make part of the construction sector but are not in the treated sub-sectors and white-collar workers in the industry. Based on a "differences-in-differences-in-differences" (DDD) estimation strategy these two groups are used as a means to back out the treatment effect of the MW on gross hourly wages. Moreover the impact heterogeneity along the wage distribution is analyzed with unconditional quantile regressions as proposed by Firpo et al. (2009).

While West German wages were on average not affected, East German employees' wages grew by 8% due to the policy. This effect is driven by significant wage growth of workers with individually bargained contracts and is insignificant for those paid under the sectoral collective agreement (CA). The positive wage impact was largest in the bottom of the wage distribution reducing thus inequality. Wage inequality across the whole distribution did not decrease substantially over time as the middle third of the wage distribution of employees under CA also benefitted from the introduction of the MW. Considering unions' role in the MW setting process and the position of its median stakeholder in the wage distribution this result is suggestive of the wage hierarchy argument. No effect on hours of work is found, nor is there any evidence for substitution of the less skilled by the more skilled workers on the intensive margin.

This study is a first step in evaluating the impact of sectoral MWs that are set in the scope of wage bargaining agreements. The evidence suggests that the institutional setting at hand is a lot more conducive to spillovers and hence larger wage effects of the MW than under statutory MWs. It also underlines that a MW introduction may affect wage dispersion and may increase wages that were not the initial target of the MW policy.

The remainder of the paper is structured as follows. Section 2.2 briefly reviews theoretical and empirical literature on the topic while Section 2.3 summarizes the state of the German construction sector at the time of the MW introduction and its institutional design. In Section 2.4 details on the data source are presented, sample selection and group

assignment are discussed and descriptive statistics provided. Section 2.5 illustrates the estimation strategies whose results are presented in Section 2.6. Finally, Section 2.7 concludes.

2.2 Previous literature

Theory derives antagonistic results with regard to employment effects of MW depending on assumptions about the labor market. Given compliance and regardless of the model assumptions, predictions of employment effects point in the same direction for the extensive and the intensive margin of labor supply and posit a positive effect on wages of those paid below the initial MW. While Zavodny (2000); Hirsch et al. (2011) find no empirical evidence for an effect on hours of work for teen employees or for the volume of work on the firm level, theoretical models further explain several channels through which the MW may also affect wages higher up in the wage distribution.

According to the model by Pettengill (1981) firms substitute the low qualified workers with slightly more qualified workers who are close substitutes if a MW is introduced. Labor demand for workers beyond the MW threshold and hence wages increases in their degree of substitutability with workers directly affected by the MW introduction. Thus, spillovers are highest just beyond the MW and decrease along the wage distribution. A competing explanation is presented by Manning (2003); in the framework of an equilibrium search model, with monopsonistic firms, employers that pay generous wages to hire workers, that are initially matched with low-wage firms, must increase their wage offers even further after the introduction of the MW to hire enough workers. Again, this effect is strongest for firms that used to pay just a little more than the new MW.

Grossman (1983) explains spillovers of the MW with the need to maintain the wage hierarchy. More skilled workers are better paid but their effort depends on the relative distance in pay to the low-skilled workers who experience a wage hike due to the introduction of the MW. This gives rise to a twofold pressure on the wages of the more skilled; first, the employers' attempt to substitute the low-skilled workers with more skilled workers shifts demand; and second, more skilled workers would reduce their effort in view of the smaller wage differential relative to the less-skilled workers if their own wages were not increased accordingly as well. Finally, a recent model proposed

by Dittrich and Knabe (2010) implements the Kalai-Smorodinsky bargaining solution as opposed to the common Nash bargain that cannot explain spillovers of the MW. Employers and unions agree on a bargain if their relative utility gains are equalized, which is defined as the ratio of the actual gain relative to the maximum feasible gain. The introduction of the MW reduces the maximum feasible gain for the employers as the best solution available now is moved up to the statutory MW. The employers' bargaining set is thus reduced which in turn leads to higher wages.

Given the questions at hand and the institutional setting of the MW in Germany, three fields of the empirical literature promise some useful insights: (1) the vast literature on MWs, particularly its effects on wages and spillovers; (2) the literature on the effect of the wage minima agreed on in collective bargaining; and as a sidestep (3) the literature on the general effect of unions and CAs on wages and wage structure, given the importance of the social partners in the German case.

Compared to the large literature on employment effects of the MW, a comparatively small number of studies focus on the effect on wages. In the UK the introduction of the National MW in 1999 is used to analyze the impact on wage growth and the wage distribution; Machin and Wilson (2004) find for UK care homes that on the home level wages rose significantly with a spike in the wage distribution at precisely the MW after its introduction; the lower end of the wage distribution was compressed (Machin et al., 2003). Dolton et al. (2010) amongst others show that positive wage effects in the lower percentiles the wage distribution beyond the MW level led to lower inequality in the bottom of the distribution after each MW hike. Dickens and Manning (2004b) detect an impact of the MW at the 5% percentile that disappears at the 10% percentile, which confirms the findings assembled by Metcalf (2004). Across the whole distribution the overall effects on inequality are small Dickens and Manning (2004a).

The findings of little or no spillovers run counter to evidence found for the US. In an early study, Grossman (1983) finds that wages for occupations just above the MW see an increase, at least in the short run as a response to a MW hike. Studies by DiNardo et al. (1996); Lee (1999); Teulings (2000) also oppose the view that the MW has little or no effect on the wage distribution. Manning (2003) follows Lee (1999) and finds, based on CPS data, that for wages just above the MW, spillovers amount up to 11% of the MW, yet the effect dies out at wages 50% higher than the MW. Katz and Krueger (1992)

and Card and Krueger (1995) analyze spillovers of the MW in fast food restaurants in Texas; 16% of firms increase wages by more than the MW hike actually forced them to and a large fraction actually maintained the wage hierarchy. Amongst companies with a starting wage 5.88% higher than the newly introduced MW, 60% increased wages.

So far three studies shed light on the different dimensions of the MW introduction in the construction sector. Using semi-parametric estimation methods to gauge the employment effect based on the shape of the wage distribution after the MW introduction Müller (2010) finds that employment in both parts of the country would have been higher without the MW (by 1-2% in West and 4-5% in East Germany) for establishments with ten or more employees. In a "difference-in-differences" (DD) framework König and Möller (2007) find positive wage effects in East Germany (1% to 3%) and (0.5%) West Germany. Individuals' probabilities to stay employed were affected negatively (slightly positively) in East (West) Germany by the MW, a result challenged on grounds of the control group's validity. As part of a comprehensive evaluation project various official micro data sources were combined, an exclusive data set constructed (IAB et al., 2011) and in a DD framework various control groups employed and tested. Altogether the bite of the MW was found to be large (small) in East (West) Germany with a positive causal effect on wages only in East Germany and none so in the rest of the country. Wage spill-overs are suggestively interpreted in a descriptive approach. The authors report no conclusive evidence for employment effects on firm employment level, firm level hours of work, individual and regional probabilities of dismissal and (re)hiring. With regard to other dimensions of adjustment to the MW the study finds no indication that substitution between differently skilled employees took place on the firm level, that the MW induced employers to revoke coverage by CA and that firms deliberately switched industry classification to evade the MW.

Another direction of spillovers may arise if employers aim to offset the higher labor cost due to the MW in the lower part of the pay distribution by reducing wages for those above the wage threshold. A large field of literature aims at explaining why in most industrialized countries, even in hard times, wages cuts are barely observed (see i.e. Bewley (1999); Howitt (2002)). Efficiency wage theories, (implicit) contract theory and fairness theory offer competing explanations for the phenomenon of downward wage rigidities (DWR). Empirical studies also emphasize the relevance of institutional

explanations like labor contracts; For Germany Franz and Pfeiffer (2006) find evidence for the role of labor union contracts and implicit contract theory in DWR, particularly for the low-skilled, and greater incidence of wage freezes in the less unionized sectors (Radowski and Bonin, 2010).

Given the important role played by the social partners in setting the MW, a closer look at the effect of union membership and more particularly collective bargaining on wages is helpful. For the US there is a vast literature on the effect of union membership (see Blau and Kahn (1999) for an overview, Card and Krueger (1995), Firpo et al. (2009) *inter alia*). A field less studied is the role of wage minima set in the scope of collective bargaining schemes. Dolado et al. (1997) analyze the case of Spain where collectively bargained minima covered about 85% of wage earners at that time and were much more binding than the statutory national minimum. They find that the collectively bargained wages significantly reduced wage dispersion and observe wage gains between 6.21% (overall) and 12.32% (semi-skilled workers) at the cost of non-negligible employment loss.

Studies on the effects of union membership in Germany in earlier years find mixed evidence; Schmidt and Zimmermann (1991) amongst others find no direct effect of individual union membership on earnings for Germany, Wagner (1991) finds a positive wage premium when restricting his analysis to blue-collar workers. Yet union density has always been a lot lower than coverage by collective agreements in Germany. In the year 2000, trade union density was only at 25% in 2000 in the overall economy, but 68% of employees were covered by collective wage bargaining (OECD, 2004, p. 145). This mirrors the fact that if an employer makes part of the employers' association and only one of his employees is in the union, the tariff is extended to all his employees (for greater detail see Haucap et al. (2006, p. 363)). Reliable information of union density at the sectoral level is, unfortunately, not available; anecdotal evidence suggests that deunionization did not spare the construction sector despite the traditionally strong presence of unions in the sector. Particularly in East Germany, firms left the employers' association. Given the German institutional setting, it is generally agreed that the debate should not so much center on the union wage premium but more on whether there is a (potentially additional) premium to coverage by a collective contract.

Based on the linked employer-employee data set of the GSES, Stephan and Gerlach (2005) find that the expected wage of the average worker is higher in establishments under a collective contract than in the uncovered regime for full-time employees in large manufacturing firms (100 or more employees) in Lower-Saxony. In another study by the authors (Gerlach and Stephan, 2006), decomposition analysis on the sample of blue-collar workers shows that under industry-wide agreements the dispersion of wages across and within establishments is always smaller than under individual wage bargaining. Fitzenberger et al. (2008) reach quite different conclusions based on a sample of male, full-time, working-age blue and white-collar workers of all industries in West German firms using the GSES of 2001. Controlling for union density effects they find a significant positive effect of the share of coverage on firm level wages yet a negative effect of individual bargaining coverage which even increases along the wage distribution.

The MW introduced to parts of the German construction sector cannot easily be compared with other countries' experiences due to its different institutional design. But the theories and empirical evidence above help to formulate ex ante some hypotheses. Under compliance the major impact of the MW introduction should be detectable in the labor market provided that the substitutability of labor with capital is limited in the industry. If the MW bite was significant wages are expected to increase most in the bottom of the wage distribution thus decreasing inequality. Given that the literature clearly shows that DWR and wage freezes are inversely related to the degree of CA coverage, it appears unlikely that the higher wage costs due to the MW were offset by lower wages for the better off employees. In the light of the different theoretical channels for wage-spillovers, the empirical evidence on spill-over effects found in other countries, and the setting of the MW in the scope of a differentiated pay scale in Germany, the MW introduction possibly might even feed through to the middle of the distribution maintaining wage hierarchy. Another route to be explored is whether firms respond to the higher cost for their low productivity workers by reducing work hours. Potentially firms substitute on the intensive margin the low wage workers with their more skilled colleagues which increases labor demand for the latter and subsequently increases wage pressure for the more skilled (paid under CA or not).

2.3 The German construction sector and the MW

Until the 1990s the German construction sector was compared to other countries highly unionized and had developed a corporatist system that ensured a comparatively high and stable pay for German workers (Eichhorst, 2005). In the following years, the German construction sector was stricken by the aftermath of the reunification boom and the dawn of the European unification. Earlier the number of posted workers from non-European countries had exceeded those from European countries. But the free movement of labor associated with the Single European Market brought ever more posted workers from EU countries. Although the number of posted workers from non-EU countries that came to Germany, based on bilateral contracts, had continually decreased throughout those years labor market tightness continued to increase. With the abolishment of seasonal employment in 1993 policy makers had, *de facto,* exhausted the tool kit of then available protectionist policies.[1]

Several other European countries faced a similar dilemma and the European Commission presented a first draft for a directive on posted workers in June 1991. Legislation by the German Parliament pre-empted the lengthy EU-level negotiations when it passed its own bill. Later only slight modifications of the German Posted Workers Act (*Arbeitnehmer-Entsendegesetz*) were needed to comply with the final EU directive issued in 1996. For the Posted Workers Act to become effective, the rate of the MW had to be determined within the scope of a CA and declared generally binding via the extension rule (*Allgemeinverbindlichkeitserklärung*). These three interacting pieces of legislation are discussed in detail below.

The CA on the MW is bargained by the organization(s) of the employers and the unions within the general negotiations between the social partners on contracts for their members in an area tariff system. Negotiations typically revolve around the tariff for the basic wage, which refers to employees with relevant 3-year vocational training and some kind of further specialization or a few years of work experience. In the main construction trade, the geographic differentiation of pay rates refers to East and West

[1] Meier and Munz (2008) discuss the role of foreign companies and workers in the light of institutional changes at the time. They document a sizable employment decline in the construction sector overall amongst foreign workers in the framework of the bilateral contracts in the early 1990s and a stark decrease in numbers of posted workers after the MW introduction.

Germany. During wage bargaining, exemption clauses can be agreed that allow deviation with lower wages or higher working hours, if the employer faces hard times. For the main construction trade, exemption clauses included wage cuts of up to 10% (5%) in East Germany (West Germany) while not underbidding the MW. Some employers also opt to pay above the general pay scale.

CAs refer to the establishment level as opposed to the judicial entity of the firm. In the main construction trade different agreements on pay scales are negotiated for blue-collar and white-collar workers. Employees fulfilling typical construction tasks are classified as blue-collar workers with the exception of head masons who make part of the white-collar work force.[2] As the highest ranking group involved in construction task, they are situated between their blue-collar colleagues fulfilling construction task and white-collar construction engineers. The pay scale for blue-collar workers was composed of more than eight different job grades at the time.

The extension rule declares the CA compulsory for all employers and blue-collar employees in the sector regardless of whether they are member of the collective bargaining parties or not. For the extension rule to be applicable, the CA must fulfill two requirements: first, it has to be passed in accordance with the law that regulates the collective wage bargaining process (*Tarifvertragsgesetz*); secondly, organized establishments must employ at least 50% of the concerned employees and the extension rule has to be of "substantial public interest".

The extension rule has to be passed by the committee of collective bargaining parties (*Tarifausschuss*) that is made up of employee and employer representatives in equal measure, before the Ministry of Labor can apply the extension rule.[3] The process to declare the CA compulsory for all employees and employers in the sector of the wage bargaining was altered later on. In order to eliminate the employers' right of veto in the committee of collective bargaining parties, the red-green coalition that came to power in 1999 changed the Posted Workers Act; since then the CA on MWs can be declared

[2] In the definition of skill groups in the basic agreement which the wage negotiation refers to head masons in the white-collar pay scale are called *Polier* whereas the highest ranked group of blue-collar workers is referred to as *Werkpolier.*

[3] This also marks the difference to a variety of other sectoral MWs discussed in Germany lately. Most of those rely on the law for minimum working standards and are not negotiated by the social partners directly.

generally compulsory by statutory regulation through the Minister of Labor. Practically, the application of the extension rule means that when organized employers negotiate with unions about the (introductory) level of the MW, they make decisions about the cost structure for all employers in the sector including their non-organized competitors.

The Posted Workers Act extends the scope of the MW, now binding on a national level, with regard to foreign firms posting workers to Germany. The Posted Workers Law thus allows the setting of minimum standards for foreign employees posted to Germany in conjunction with the commensurate extension rule at the industry level. Along the way, it opened a loophole to set a MW for all German employees in the sector.

The construction industry consists of several sub-sectors. In the official micro data an establishment, it is assigned to the sub-sector where it generates the major part of its value-added. To switch sectors an establishment must shift the greatest part of its economic activity.[4] The social partners are grouped along the lines of certain sub-sectors or groups of sub-sectors. Great parts of the main construction trade are represented by two employers' organization (The *Zentralverband Deutsches Baugewerbe* and the *Hauptverband der deutschen Bauindustrie*) and one union (*Industriegewerkschaft Bauen-Agrar-Umwelt*).

A MW rate applied to the bigger part of employees in some of the 4-digit-level construction sectors starting in January 1997. However, sub-sectors other than the main construction trade have traditionally had their own structures and negotiated their own CAs. Electric installation, roofing, painting, and wreckage in construction sooner or later introduced their own MWs. Therefore a sizable number of construction sector employees were not initially covered, but were eventually covered by a MW agreement. MW introduction to the main construction trade had been delayed by approximately

[4]Employers could have tried to escape MW coverage by shifting the major part of their economic activity to a non-covered sub-sector while generating a marginally smaller fraction of value-added in economic activities typical of the covered sector. The combination of occupations, thus the skill input by workers, neither change greatly in the covered nor in the non-covered part of the construction industry; this indicates that dodging the MW legislation by switching industry affiliation is not an issue. Given the subsequent introduction of MW in neighboring sub-sectors such behavior would have been short-sighted. IAB et al. (2011, p.163) analyze this question with administrative data from the employment agency and find no evidence of a systematic reclassification of establishments towards sectors not covered by the MW.

12 months due to the rejection of the policy by the employers' side and ongoing discord within the different bodies involved. The employers' organizations in the main construction trade were not generally opposed to the introduction of a MW, but the umbrella organization of employers was strictly opposed and slowed the introduction. As a compromise with regard to employers' opposition to its introduction, the MW was to be reduced after its first phase when it finally came into effect.[5]

The MW is an hourly and establishment based concept that is thus differentiated with regard to its validity in terms of sectors covered and employees covered. At the employee level, only blue-collar workers above 18 and not on vocational training are eligible, regardless of their tasks and level of education. A few professions are explicitly excluded (i.e. kitchen aids, security guards, delivery and cleaning personnel). With the introduction of the MW, a new wage group was created in the pay scale of the CAs.[6] It was agreed that this group should be situated below the, until then, lowest paid group of unskilled laborers in non-construction occupations.

Table 2.1: The Development of the Minimum Wage across Time (in €)

		East	West
January 1997	- August 1997	8.00	8.69
September 1997	- August 1999	7.74	8.18
September 1999	- August 2000	8.32	9.46
September 2000	- August 2001	8.49	9.65
September 2001	- August 2002	8.63	9.80

Source: Tarifsammlung Bauwirtschaft 1997/1998, 1998/1999, 1999/2000 and 2001/2002, Elsner Verlag.

In West Germany the MW was set to 90.55% of what the lowest wage group had earned at the time the MW came into effect. In East Germany this difference was marginally smaller with 8.34 percentage points distance. Social partners set the level of the MW without any formal knowledge of their competitors' wage structure. At

[5]More information on the political mayhem surrounding the MW introduction can be found in German at http://www.boeckler.de/27758_21459.html

[6]In September 2003 an additional MW for workers with vocational training was implemented, so called *ML2*).

the time of the MW negotiations no data base with reliable hourly wage information differentiated along wage regime was available. Table 2.1 shows the path of the MW from its introduction in January 1997 through August 2002. The nominal MW increased by 7.86% (12,77%) in East (West) Germany during this time.

2.4 Data, differentiation of treatment and control groups & descriptive evidence

2.4.1 The GSES

This study is based on official micro data from the GSES, the German salary and wage survey (Hafner and Lenz, 2007).[7] Every few years, it collects a cross section of data from establishments (*Betrieb*) with 10 or more employees. At the employee level, the GSES collects information on wages, hours worked, overtime, (payroll) taxes, education, job description, a rough classification of the tasks fulfilled in terms of intra-firm hierarchy, and time with the employer amongst other things. At the establishment level, it collects the region, the industry code, number of employees, fraction of blue and white-collar workers, fraction of men and women, and participation in CAs is collected. The data does not contain any information on job quits. As the GSES is collected by government officials,establishments are required to respond if sampled and non-response is low.

I use two cross sections of the data from October 1995 and October 2001, restricting the sample to employees between 18 and 65 years of age, and neither under vocational training nor internships. The data allow for an accurate calculation of hourly wages since the gross wage can be broken down into normal labor income and labor income due to overtime, time worked on weekends, and bank holidays. Any extra pay is subtracted from the pay bill for October and hours according to contract are used to compute hourly wages since the variable on hours paid only exists for 70% of observations in the sample.[8] For estimation results it does not make a difference if I use log gross hourly

[7] Since 2006 it is called *Verdienststrukturerhebung*.

[8] Hourly wage=[gross wage for October-remuneration for extra work-remuneration for shifts worked-remuneration for work on weekends/bank holidays-remuneration for night shifts]/(weekly work time according to contract*4.3)

wage based on total working hours or log of monthly labor income as the dependent variable instead of hourly wages based on hours according to contract. Hourly wages calculated to be lower (higher) than €3 (€150) were not considered in the analysis for plausibility. The data discern between individual wage contracts, coverage by a CA, firm or establishment agreement. If not explicitly mentioned otherwise the term "collective agreement" (CA) will be used as a synonym for all three types of agreements in the following. The variable on the difficulty of tasks fulfilled captures differences in education needed for the job and degree of responsibility; yet it is not possible to identify the pay scale as implemented in the CAs.

2.4.2 Treatment and control groups

The sectoral MW was passed on a national scale and differentiated in its level with regard to East and West Germany. For that reason geographical variation cannot be used to construct treatment and control group as is commonly done in the literature. Yet I exploit the fact that not all workers in the construction industry became eligible. Two subgroups within the industry lend themselves readily as control groups; blue-collar workers from other sub-sectors in construction and white-collar workers. As explained in more detail in Section 2.5 I use these two control groups together to back out the treatment effect that goes beyond general time, (sub)industry, and worker type effects.

Table 2.2 outlines the choice of treatment and control group in terms of the 4-digit-industry classification. Some sub-sectors of the construction industry are not suitable neither for the treatment nor for the control group. The 4-digit-industries were excluded due to one of the following two reasons; (1) Industry classification on the 4-digit-level changed between 1995 and 2001 from SYPRO code to WZ93 in 2001. Conversion from one to the other is in some cases not unambiguously possible. (2) As explained in Section 2.3 a few other sector-specific MWs were introduced from 1997 on. Sectors that passed their own MW rate in 1997 were excluded. For simplicity the finally chosen sectors are referred to as "treatment and control sectors" below.

Another source of differentiation within the construction industry is the distinction between blue and white-collar workers. MW legislation exclusively covers blue-collar workers in the treatment sectors. As the data set is a linked employer-employee data set one observes wages for blue and white-collar workers that are employed at exactly

Table 2.2: Treatment and Control Group along the lines of the 4-digit-industry classification, sectors that cannot be assigned in gray font

Treated sectors	**Industry code**
General constructions or parts thereof; civil engineering	4521
Construction highways, roads, airfields and sport facilities	4523
Construction of water projects	4524
Other construction work involving special trades	4525
Control sectors	
Plumbing	4533
Other building installation	4534
Floor and wall covering	4543
Painting and glazing	4544

Source: Federal Statistical Office (http://www.destatis.de/EN).
Notes: Structure of the sectors and subsectors according to the German Classification of Economic Activities ("Klassifikation der Wirtschaftszweige"), Edition 1993 (WZ 93).

the same establishments. In view of general shocks affecting an establishment white-collar workers thus constitute another natural comparison group for their blue-collar colleagues.

2.4.3 Descriptive evidence

Figure 2.1 displays the distribution of gross hourly wages in East and West Germany before and after the introduction of the MW for blue-collar workers in establishments for both the treatment and control sectors. For comparison gross hourly wages in 1995 were inflated to 1997 and the MW rates as of October 1997 and October 2001 were added as reference lines in the subfigures for the covered sectors. Plots for the control sectors display the familiar bell-shaped distribution of wages in both years and both parts of the country in the control sectors. Inspection of the top left panel shows that in East Germany a non-negligible range of wages of blue-collar workers in the covered sector was below the MW to be introduced quite in contrast to the West German situation depicted two panels further down. While the histograms for eligible workers are of similar shape in West Germany for both points in time, this is not the case for East

Germany after the introduction of the MW. The histogram in the top right panel reveals a very pronounced heaping of wages to the right of the MW for East Germany in 2001. For 2001 29.05% of blue-collar workers in the treated sectors of East Germany received wages in the range of the MW and 10 percentage points above. In West Germany this fraction amounts to a comparatively meagre 4.32%.

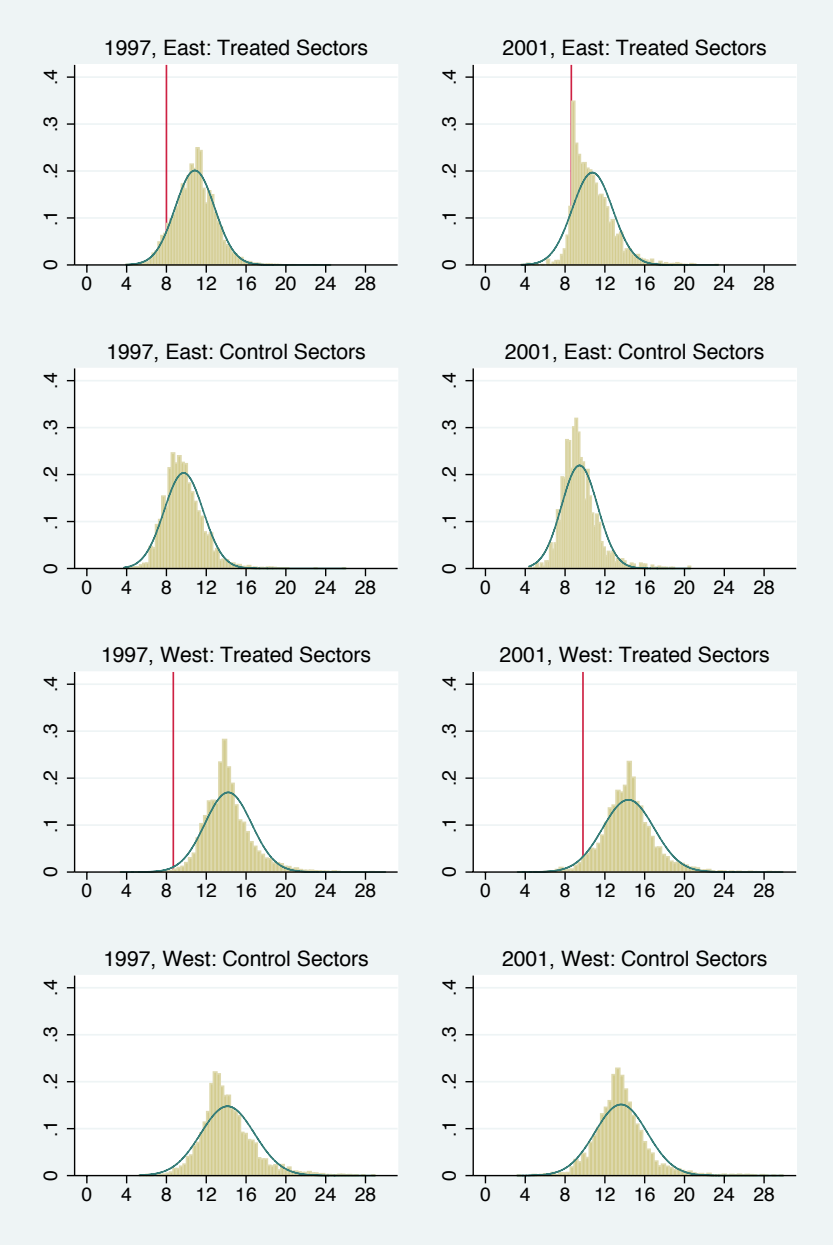
Table 2.3 further underlines the differential impact of the MW across the country; while in East Germany 10.65% of eligible workers have hourly wages below the MW, this only holds true for 0.44% in West Germany. The Kaitz index, as the ratio of the nominal MW to the median of hourly wages, further supports that the MW bit a lot more in East Germany than in West Germany. While the MW amounts to 81% of the median of gross hourly wages of all employees in East Germany before the reform, the Kaitz index for West Germany equals 63%. The index is of similar value for both regions in 2001 and comes very close to the Kaitz index as calculated by König and Möller (2007). For comparison: In none of the OECD countries with a statutory national MW did the Kaitz index (OECD, 2010) reach more than 55% between 1995 and 2001, while the unweighted average across countries amounts to roughly 35%.

Table 2.3: Details on Eligible Employees with Gross Hourly Wages below the Initial Minimum Wage in 1997

	East	West
Kaitz index (median of wages in all sectors)	81%	63%
Kaitz index (median of wages for all eligible observations)	77%	63%
Eligible workers below the minimum wage		
... number of observations	877	61
... average establishment size	36	48
... as a fraction of all eligible workers	10.65%	0.44%
... average age	34	30
... fraction low-skilled	55%	74%
... average tenure in months	23	25

Source: GSES 1995.
Notes: weighted calculations based on wages inflated to level of 1/1997 using data from www.destatis.de.

Figure 2.1: Distribution of Gross Hourly Wages in 1997 and 2001 for blue-collar workers in East and West Germany



Source: GSES 1995 and 2001.
Notes: own calculations based on gross hourly wages of October 1995 inflated to October 1997 using data from www.destatis.de. Reference lines plot the respective MW rates as of October 1997 and 2001.

Table 2.13 in the Appendix shows average characteristics of all workers in both periods. Blue-collar workers in the treated establishments are predominantly male and work full-time (columns 2 and 3). Coverage by a collective, firm or plant level agreement is particularly high in West Germany. The composition of occupations in treatment and control group remains stable across time. Table 2.3 provides as a comparison some average values for those earning below the MW prior to its introduction. Not surprisingly, on average the younger employees have less than half of the average tenure of the full sample, and are paid below the level of the MW to be introduced. Those paid below the MW work predominantly in positions requiring less skills and training. On average they are employed in smaller establishments. This is in line with the descriptive evidence of a study by Müller and Steiner (2010a), which shows that it is predominantly employees in smaller firms whose wages would fall short of a hypothesized economy wide MW.

Complying with the nominal MW rate would have meant a wage growth between 10.96% and 12.83%,[9] on average, for entitled workers below the MW in East Germany before the policy reform. Adjusting wages for those below the new threshold and keeping all other workers in the eligible group at their actual wage level reveals a hypothetical average increase of at least 1.17% for the overall group. In the Western part of the country such nominal adjustment would have entailed a 11.80% to 12.59% (0.05%) increase for those entitled below the MW (everyone entitled).

Inequality measures in Table 2.4 show a heterogeneous development of wage inequality across groups (with and without CA) and within groups across the distribution. Overall inequality as measured by the Gini index declined most in East Germany for wages of those not bound by a CA (-14.65%). Measures concentrating on the lower part of the distribution emphasize that the decrease in inequality was most pronounced in the bottom of the distribution; the distance between the 10th percentile and the median decreased by roughly 50% in the above sub-group. For the group of employees bound by a CA, inequality indicators changed to a smaller extent, experiencing partly a slight

[9]The size of theoretical wage growth needed for compliance hinges on the assumptions about wage inflation between October 1995 and January 1997. Assuming the general hourly wage inflation for the entire economy should constitute a lower bound given the unfavorable developments in the construction sector compared to the economy as a whole. As an upper bound, the theoretical wage growth under compliance with no inflation adjustment is provided.

Table 2.4: Wage dispersion between employees covered by the MW

		without CA				with CA			
		Gini	MDL	Distance of ... pct. to median		Gini	MDL	Distance of ... pct. to median	
				10^{th}	90^{th}			10^{th}	90^{th}
East	before	0.0998	0.0161	0.2432	0.2193	0.0904	0.0149	0.1902	0.1825
	after	0.0852	0.0126	0.1192	0.2356	0.0984	0.0160	0.2189	0.2265
West	before	0.1173	0.0239	0.2542	0.2718	0.0813	0.0114	0.1760	0.2037
	after	0.1116	0.0212	0.2874	0.2321	0.0899	0.0140	0.1950	0.1876

Source: GSES 1995 and 2001.
Notes: MDL refers to the mean log deviation index, and the last category lists the distance to the median wage for the 10^{th} percentile and the 90^{th} percentile respectively.

increase. As the MW was introduced as an additional lowest wage category to the pay scale, this comes not as a surprise.

2.5 Methodology

2.5.1 Difference-in-differences-in-differences estimation

The construction sector went through troubled times in the 1990s. The industry contracted as a whole, while anecdotal and descriptive evidence suggest further that some sub-industries and establishments were hit harder than others during the downturn.

In order to not confound the effects of the policy with general time, industry and worker type effects the two control groups defined in Section 2.4.2 are used to separate out the treatment effect. In the familiar DD framework, the common trend assumption must not be violated. Given the unequal pressure on the labor market of construction industry's sub-sectors described above it is implausible to hold up the assumption that in the absence of the policy wages of blue-collar workers in the treated and the control sectors would have experienced the same time trend. White-collar workers in the treated sectors make a doubtable control group as well in view of comparable time trends for blue and white collar workers in the medium run perspective.

The DDD framework holds the advantage that its identifying assumption is considerably less restrictive. In this particular case it requires that, in the absence of the policy,

the difference in time trends of wages for blue- and white-collar workers in the treated sectors would have been the same as the difference in time trends of wages of blue- and white-collar workers in the control sectors. The DDD framework thus allows for a differential overall trend in control and treatment sectors as much as for a differential time trend in blue- and white-collar workers' wages. The typical placebo experiment shifts the treatment period backwards in time and confirms the DD(D) assumptions if no significant treatment effect can be identified. As the GSES is not consistently available before 1995, I use a placebo experiment across sectors. The control sectors are redefined as treated and an upstream or respectively a downstream industry (placebo I and II) substitutes for the initial control group. The production of cement and structural ceramics (*Zementherstellung & Baukeramik*) are an upstream industry producing the major inputs for the treated sector, the main construction trade. The initial control group (painting and electric installation) would be finishing up the houses built based on the inputs of the earlier two sectors (production of cement and structural ceramics and the construction business) and should thus constitute a viable group for a placebo experiment exhibiting similar economic dynamics. Furniture manufacturing can be regarded as an even closer neighbor to initial control group; if one newly builds or refurnishes a house or office he most likely will commission firms in both sectors to paint the walls, take care of the electric installation work and finally buy furniture. As an upstream and a downstream industry both groups chosen for the placebo experiment should thus feature similar macroeconomic trends but its employees are clearly not covered by the MW. Also IAB et al. (2011, p.74 ff.) develop an index to measure the quality of different industries as control groups for their chosen DD approach and consider similar control groups. It is worth keeping in mind though that their index is based on measuring the general common trend between the treated sector and potential control groups whereas for the analysis at hand the difference in time trends for blue and white collar workers across industries is decisive for a valid inference. The quantitative measure cited above thus cannot be applied directly to the analysis employed here.

Proper identification may also be in jeopardy if (1) treated firms substitute blue-collar workers with blue-collar workers from the control sectors or with white-collar workers; (2) if the wages of white-collar workers or blue-collar workers in the control sectors increase due to spill-over effects of the MW. While such spillover effects cannot

be ruled out categorically, several points worth noting provide reassurance. The treatment and control sectors employ workers of very different occupations and vocational training (brick masons vs. painters and installers) provided the type of output they produce.[10] As pointed out by IAB et al. (2011, p.39, 493) do 86% of the interviewed employees term themselves as blue-collar worker and nearly the same fraction (80%) states that their vocational training is specific to the construction sector. This gives indication that exchanging blue-collar workers with white-collar workers is not straightforward, i.e. in East Germany the fraction of white-collar workers remained between 18% and 19% across time.

In the spirit of the wage hierarchy argument wage spillovers to all kinds of white collar workers could occur to maintain the relative distance between pay across the entire wage structure in the sector. While wage contracts for blue- and white-collar workers are bargained at the same time, each contract though refers to a different pay scale. As in the pay scale for blue-collar workers the pay scale for white-collar workers is highly detailed with regard to occupation, education, work experience and tasks fulfilled. A certain fraction of white-collar workers is also being paid outside and above the collective agreement. Already before the introduction of the MW the general wage level was on average roughly a third higher for white-collar workers. One can also hypothesize how well the wage hierarchy argument holds for employees with quite different educational backgrounds and occupations. But there actually is one group of white-collar employees that raises particular concern, namely head masons and foremen. They are classified as white-collar workers in the wage bargaining and the data. Yet their tasks are closest to those of the eligible workers and therefore appear the most susceptible of spillover effects. As a robustness check this group of employees is excluded from the baseline estimation and results barely change (see Tables 2.6 and 2.5).

[10] A simple comparison across time shows that in 1995 roughly 87% of blue-collar workers worked in occupations characteristic of the treated sector and this fraction remains at 86% in 2001 in both parts of the country.

Let the DDD estimator be defined as:

$$\begin{aligned} log(wage_{gm}) &= \beta_0 + \beta_1 * blue_{gm} + \beta_2 * post_g + \beta_3 * sector_g \\ &+ \beta_4 * (blue_{gm} * post_g) + \beta_5 * (blue_{gm} * sector_g) + \beta_6 * (post_g * sector_g) \\ &+ \beta_7 * (blue_{gm} * post_g * sector_g) \\ &+ \mathbf{e_g'}\mu + \mathbf{p_{gm}'}\delta + \upsilon_{gm}, \end{aligned} \tag{2.1}$$

where establishments are indexed by $g = 1, ..., G$. Blue- and white-collar employees 1 through M_g work for establishment g. $log(wage_{gm})$ is thus the log gross hourly wage for individual m working at establishment g. e_g is a $K \times 1$ vector of establishment specific covariates and p_{gm} is a $L \times 1$ vector capturing explanatory variables that vary within and across establishments, thus for each individual. $blue_{gm}$ is a dummy variable equal to one if the observed individual is a blue-collar worker; $post_g$ is a dummy equal to one if the individual is observed after the policy change; $sector_g$ is the industry dummy and equal to one if the individual works for an establishment in the treated sector; the error term is denoted υ_{gm}. The coefficients of the double interactions with $post_g$ capture reform-independent differential time trends that affect all blue-collar workers or all workers in the construction industry covered by the reform. The double interactions with $blue_{gm}$ control for time-invariant differences between blue-collar workers and other workers in the covered sector. The coefficient of the third-level interaction, β_7, is the DDD estimate of the impact of the MW reform. It captures the mean treatment effect of the MW introduction on wages of eligible blue-collar workers in the treated sectors.

Several control variables are added to mimic a Mincer-type wage equation. Age and age squared capture the typical age profile in labor income earnings. Dummies control for gender and full-time work. The data set does not provide information on work experience but includes information on time with the current employer. I include tenure in months to account for potential effects of longer periods with the same employer on wages. The variable on difficulty of tasks fulfilled is recoded in three dummy variables for low, medium or high qualifications (reference category) needed on the job. Finally, dummies for 5 different establishment size categories are added with the smallest (10 to 20 employees) as the base value.

The estimation equation explained above identifies the impact of a policy common to all firms within a sector on wages that vary between employees. While the policy is constant for all individuals within the sector and thus the firm, a shock to several or all individuals in that group may lead to correlation of wages within the chosen group. Bertrand et al. (2004) point out in their canonical study that in such a setting the error term of equation (2.1) incorporates a group specific effect and in case of positive correlation significance levels of the treatment effect are overstated. Several others have picked up on the problem (also see i.e. Wooldridge (2006); Cameron et al. (2008)). Donald and Lang (2007) show in detail how Moulton's critique of estimation with grouped data applies to DD estimation. They show that with a large enough number of clusters robust standard errors on the group level can alleviate the problem. For the estimation equation at hand clustering standard errors on the establishment level is the chosen approach. It purges the impact of establishment level shocks on wage correlation but cannot account for any higher level shock occurring at the same time. Cluster robust standard errors estimated for specification (2.1) up to triple the conventional robust standard errors.

A problem common to all MW studies is obviously non-compliance; given that the study at hand uses official micro data the existence and if so degree of non-compliance cannot be determined properly. Anecdotal evidence collected by IAB et al. (2011, p. 160ff.) shows that employers, unions and other players disagree widely in their appraisal of how large of problem non-compliance constitutes. Non-compliance is thought to be a greater problem in the very small establishments which are not covered by the data base employed here. A widely cited practice to circumvent the MW is to officially employ a worker half-time but actually have him work full-time and not remunerate him for the extra work. If the hourly wages rates calculated are based on only half of the actual working time such non-compliance would clearly bias the treatment effect on wages upward. In the GSES used here the fraction of full-time workers in the treated sector though remains at the high levels from before the policy.

2.5.2 Unconditional Quantile Regression

The DD(D) methodology allows for identification of the mean treatment effect of a policy. During the public debate, the MW was presented as a means to better support those employees receiving the lowest pay. Thus, the target group of the policy are

the lower ranks of the wage distribution. If this promise of policy makers had come true, one should be able to identify higher effects at the lower quantiles of the wage distribution and lower, possibly zero or even negative effects in the higher ranks of the wage distribution. In contrast to conventional OLS, quantile regression (QR) models, as first introduced by Koenker and Bassett (1978), allow the capture of such heterogeneous effects across the wage distribution.

Often covariates, other than the industry dummy, change along the wage distribution, e.g. observations in the lower tail of the wage distribution are typically less educated and younger. Conditional QR estimates describe how the wage is affected at a particular quantile, given the explanatory variables. A drawback of the traditional quantile regression approach is its limited scope for interpretation. Unlike conditional means in a least-squares regression, conditional QR estimates do not average up to the unconditional mean. We can thus interpret conditional QR coefficients only as effects on the distribution conditional on observations sharing the same values of covariates. Firpo et al. (2009) propose a new method to estimate the impact of changes in the explanatory variables on the unconditional quantiles of the outcome variable which they termed the Recentered Influence Function (RIF) regression.

RIF regression basically consists of two steps; first the dependent variable is transformed via the RIF, second, a regression is run of the transformed dependent variable on the explanatory variables. For simplicity $i = 1, ..., N$ represents an index across individuals that uniquely identifies each observation in the full sample and across time in the following. Each element of i thus corresponds to one single combination out of the employer g and employee m identifier. Let the unconditional (marginal) distribution function of wages, Y, be $F_Y(y) = \int F_{Y|X}(y|X = x) \cdot dF_X(x)$ such that the the density of Y evaluated at τth population quantile, q_τ, is $f_Y(q_\tau)$.

The RIF is defined as the sum of the distributional statistic of interest and its influence function which measures the influence of an individual observation on the distributional statistic. In the case of quantiles the RIF is

$$RIF(y; q_\tau) = q_\tau + IF(y; q_\tau) = q_\tau + \frac{\tau - \mathbb{1}\{y \leq q_\tau\}}{f_Y(q_\tau)} = c_{1,\tau} \cdot \mathbb{1}\{y > q_\tau\} + c_{2,\tau},$$

where $c_{1,\tau} = 1/f_Y(q_\tau)$ and $c_{2,\tau} = q_\tau - c_{1,\tau} \cdot (1-\tau)$. The RIF equals the underlying distributional statistic in expectation. Conditional on some explanatory variables X the expectation of the RIF can be written as $E[RIF(Y;q_\tau)|X=x] = c_{1,\tau} \cdot Pr[Y > q_\tau|X=x] + c_{2,\tau}$ and is termed unconditional quantile regression because its average derivative corresponds to the marginal effect on the unconditional quantile. The authors further show that the unconditional effect $E[dE[RIF(Y,q_\tau)|X]/dx]$ is closely related to the average marginal probability response model $Pr[Y > q_\tau|X]$ and the family of conditional quantile effects. In case of a simple linear relationship between covariates X and the dependent variable estimation of the conditional expectation $E[RIF^{OLS}(Y;q_\tau,F_Y)|X=x] = X'\gamma_\tau$ leads to the unconditional quantile regression coefficient $\widehat{\gamma}_\tau = \sum_{i=1}^{N}(X_i X_i')^{-1} \sum_{i=1}^{N} X_i * \widehat{RIF}(Y;\widehat{q_\tau})$.

For computation of $\widehat{RIF}(Y;\widehat{q_\tau},F_Y)$ $\widehat{q_\tau}$ and $f_Y(\widehat{q_\tau})$ need to be estimated. The estimate of the τth sample quantile is deduced by solving

$$\widehat{q_\tau} = \arg\min_q \sum_{i=1}^{N} (\tau - \mathbb{1}\{Y_i - q \leq 0\}) \cdot (Y_i - q).$$

The density of the Y is estimated using the kernel density estimator. In the second step $\widehat{RIF}(Y;\widehat{q_\tau})$ is regressed on the independent variables.

In order to analyze treatment effect heterogeneity along the wage distribution RIF regression is combined with the linear DDD model described in Section 2.5.1. Regressors for the RIF regression are just the same as in the least squares specification written out in equation (2.1).

2.6 Results

2.6.1 Differences-in-differences-in-differences results

For all specifications additional controls such as age, gender, skill, tenure and establishment size are included. Table 2.5 and 2.6 summarize the main estimation results of the DDD specification for East and West Germany. Detailed regression output is supplied in the Appendix (Tables 2.10 and 2.11). Standard errors are clustered on the establishment level in all specifications to account for correlation of error terms within establishments.

The first column "DDD" of Table 2.5 shows estimation results for the base specification (2.1). In the rest of the columns interactions of the variables *blue*, *sector*, *post*, $blue * post$, $blue * sector$, $sector * post$, and $blue * post * sector$ with coverage by a CA were added and different sample restrictions made. Model "$\leq$200" restricts the sample to establishments with up to 200 employees. This excludes only a few establishments yet they provide many observations. The column to the far right provides estimation results when the sample is restricted to employees whose wage contract is not part of a firm or establishment level agreement. Firm and establishment level agreements are typically found in larger firms, but also, to a smaller extent, in medium-sized companies.

Table 2.5: Overview of main differences-in-differences-in-differences results for wages in West Germany

	(1) all	(2) all	(3) placebo I	(4) placebo II	(5) no firm CA	(6) no large firms	(7) no foremen
Blue*post*sector	0.017	0.056	0.060	0.017	0.056	0.055	0.056
	(0.020)	(0.038)	(0.046)	(0.042)	(0.038)	(0.040)	(0.041)
Blue*post*sector*CA		−0.024	−0.061	−0.014	−0.022	−0.046	−0.022
		(0.044)	(0.053)	(0.054)	(0.044)	(0.044)	(0.047)
Blue*post*sector + blue*post*sector*CA		0.033	−0.001	0.003	0.034	0.009	0.034
		(0.024)	(0.027)	(0.031)	(0.024)	(0.023)	(0.026)
R^2	0.569	0.572	0.548	0.523	0.572	0.536	0.561
N	53,651	53,651	32,690	36,413	53,525	36,939	51,680

Source: GSES 1995 and 2001.
Notes: standard errors clustered on the establishment level in parentheses. ***significant at 1% level, **significant at 5% level, *significant at 10% level. The dependent variable is log hourly wages. "CA" refers to collective, firm or establishment agreement. "DDD-CA" stands for least squares estimation of the differences-in-differences-in-differences specification differentiated along union status. "<200" restricts the sample to observations in establishments with up to 200 employees. "no firm CA" excludes observations from establishments with a firm or establishment level agreement. For further details and the full regression output refer to Table 2.11.

Results for West Germany confirm that there was no significant mean treatment effect of the MW. This holds across the different specifications and sample restrictions. While point estimates suggest a slight positive impact, none of the coefficients are significantly different from zero. The magnitude of effects is stable across specifications except for the overall point estimate ($blue * post * sector + blue * post * sector * CA$) for the effect on blue-collar workers not covered by a CA in the sample restricted to establishments with 200 employees, yet also this point estimate is insignificant. The test statistic the F-Test (11.03) on jointly zero slopes (and intercept) in the interacted model

again supports group heterogeneity in treatment. The negative and significant base effect of coverage by collective contracting ("with CA") are in line, albeit a little smaller than the findings by the study of Fitzenberger et al. (2008). Compared to blue-collar workers in the treated sectors after the introduction, the penalty for individuals under CA is barely detectable (-0.5%) and insignificant. Column "no foremen" of Table 2.11 shows that estimation results do not change when head masons and foremen that are classified as white-collar workers are excluded from the regression. In columns (3) and (4) the validity of the chosen approach is put to a test by means of the cross-sectional placebo regressions outlined in Section 2.5.1. In both specifications the coefficients of interest turn out insignificant supporting the choice of control groups.

Table 2.6: Overview of main differences-in-differences-in-differences results for wages in East Germany

	(1) all	(2) all	(3) placebo I	(4) placebo II	(5) no firm CA	(6) no large firms	(7) no foremen
Blue*post*sector	0.081***	0.130***	−0.052	0.003	0.130***	0.109***	0.136***
	(0.028)	(0.036)	(0.039)	(0.063)	(0.036)	(0.038)	(0.038)
Blue*post*sector*CA		−0.0126		−0.0799	−0.0301	0.00355	−0.0161
		(0.076)		(0.098)	(0.083)	(0.079)	(0.078)
Blue*post*sector + blue*post*sector*CA		0.117*		−0.077	0.100	0.112*	0.120*
		(0.063)		(0.065)	(0.070)	(0.064)	(0.066)
R^2	0.579	0.585	0.488	0.491	0.591	0.548	0.571
N	27,640	27,640	14,744	13,407	26,903	21,986	26,873

Source: GSES 1995 and 2001.
Notes: Refer to Table 2.5 for general details and to Table 2.10 for full regression output.

In East Germany the mean treatment effect is clearly positive and significant. The F-Tests confirm overall group heterogeneity with regard to CA albeit that the interaction of the treatment effect with wage bargaining regime is not significantly different from zero. But while the treatment effects for those under the non-covered regime are highly significant in all regressions, estimates for effect of the MW on wages of those under CA are on the brink of significance. The base effect of coverage by a CA is large and significant with 11% in contrast to the results for West Germany. Among the blue-collar workers in the treated sectors, wages under collective contracts were 7.3% higher than for those with individual wage contracts after the policy had been implemented. When employees contracted under firm and establishment level agreements are left out of the

sample (column "no firm CA" in Table 2.6) the treatment effect is not significantly different from zero for those under collective contract. Compared to the sample restriction with regard to establishment size (column "≤200"), a lot fewer observations are left out of the estimation, but these observations stem from only a few establishments underlining the particular dimension of firm/establishment specific agreements. Placebo regressions show no significant treatment coefficients. Two interpretations come to mind as a potential explanation why effects for those under collective agreement are not clearly zero. If unions strive to maintain the wage differential between their members and those not bound by a collective agreement they have to push up the bargained wages for their members to maintain the wage premium. Alternatively the mechanism by Manning (2003) pointed out before provides an intuition keeping in mind that collective agreements are of comparatively low relevance in East Germany relative to West Germany. According to this reasoning organized employers pay generous wages to employ workers that were initially matched with low-wage firms not bound by a collective agreement. After the introduction of the MW they must increase their offer to lure employees in low-wage firms away from their now relatively better paid jobs.

Table 2.7: Main Differences-in-Differences-in-Differences Results for Hours

	East Germany				West Germany		
	(1) all	(2) no firm CA	(3) placebo II	(4) all	(5) all	(6) placebo II	(7) all
Blue*post*sector	0.002	0.002	-0.003	0.002	0.009	0.003	0.009
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.007)	(0.006)
Blue*post*sector*LS				0.000			0.001
				(0.011)			(0.008)
Blue*post*sector + blue*post*sector*LS				0.002			0.009
				(0.010)			(0.007)
R^2	0.103	0.109	0.138	0.103	0.131	0.239	0.185
N	27,123	26,388	13,036	27,640	51,623	34,193	53,651

Source: GSES 1995 and 2001.
Notes: Refer to Table 2.5 for general details and to Table 2.12 for full regression output. LS refers to low skilled workers (no vocational training.)

Table 2.7 shows that across the whole country hours of work of full-time employees did not change in response to the MW policy. To test whether the wage increase of the least productive employees led to substitution along the intensive margin by more qualified workers the sample is split along the skill dimension in columns (4) and (7). Low skill is defined as an employee doing work that does not require construction specific vocational training. Estimation results reveal no significant treatment effect, neither for the low-skilled nor for the more skilled. This lends no support to the hypothesis that the MW leads to a substitution of working hours of the low-skilled by those of the more skilled. It relates to the analysis by IAB et al. (2011) who find on the (regional) firm level no indication of substitution between different types of employees and effects on the volume worked.

While there is no evidence for an effect on work time the MW introduction led to an average wage growth of 8% for all entitled blue-collar workers in East Germany. Further differentiating by wage bargaining regime reveals a surprisingly high positive effect of 13% on wages of those under individual contract, which is close to the calculated theoretical wage increase needed for those observations prior to the introduction below the MW. Regressions for the effect on monthly earnings show the same patterns and magnitudes as those on hourly wages for both parts of the country. In a next step, the question who benefitted the most along the distribution is addressed.

2.6.2 Unconditional quantile regression results

Figure 2.2 shows graphically the main coefficients and the respective confidence intervals for RIF coefficients. The two panels on the left refer to results for workers under individual bargaining (a) and covered by a CA (b) for East Germany and the panels to the right refer to the results for West Germany (panels (c) and (d) respectively). Tables 2.8 and 2.9 in the Appendix provide detailed estimation results at selected quantiles.

For West Germany OLS regressions find no significant mean effect of the MW on wages for non-covered workers. This result is confirmed along the whole distribution by RIF regression results. The coefficients are quite small and never significantly different from zero. The mean effect for employees under CA was not significant either but RIF results show a non-homogeneous picture along the distribution. Up till the 30%-percentile coefficient estimates meander around zero and are insignificant. A significant

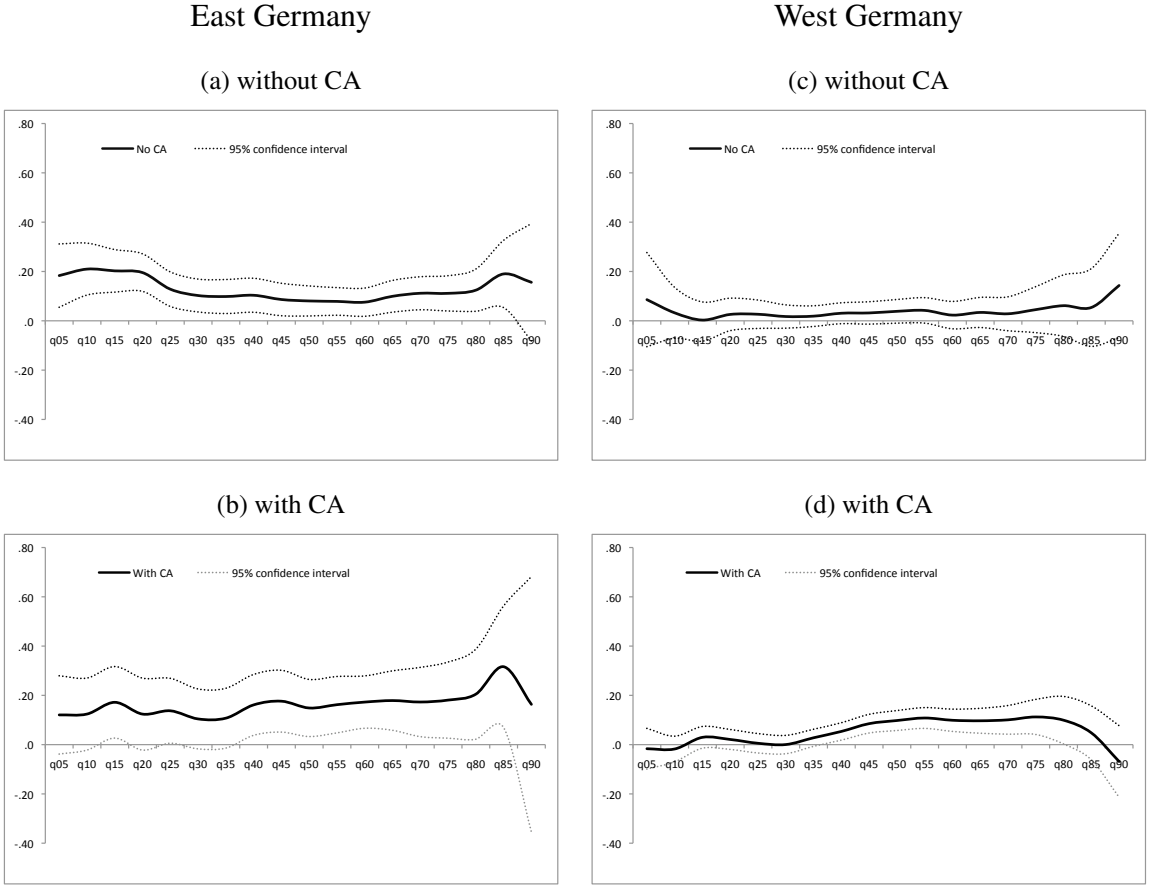
wage-increasing impact of the MW is detected in the middle of the distribution, between the 40%- and the 80%-percentile. If the union's median voter is considered to be a blue-collar worker who has completed a relevant three-year vocational training and some years of work experience, this is the region of the wage distribution where his wage is situated according to the pay scales.[11] Coefficients range between 5.4% and 10.1% producing greater wage dispersion and inequality in the middle third of the distribution.

The treatment effect for blue-collar workers under individual contracts in East Germany is positive along the whole distribution. It is highest between the 5%- and the 25%-percentile and remains quite stable for the higher quantiles. The MW introduction thus clearly decreased inequality in the lower part of the distribution confirming the first impression captured by the inequality measures. For workers under CA a positive effect occurred in the part of the distribution where the mass of the union's stakeholders is located, maintaining their relative distance to the MW. Effects in the lower part of the distribution are not very precisely estimated. They are of smaller magnitude and loose in significance when wage contracts bargained on the establishment level are excluded. Yet, in the left tail estimated coefficients are only on the brink of significance at the 95%-level and just beyond the 40%-percentile coefficients are clearly significant.

RIF regression results thus complement the information on mean effects. While OLS regressions for West Germany suggested that the MW exerted no impact at all on wages, RIF regressions reveal that, for observations under CA, a sizable and clearly significant effect in the upper part of the wage distribution took place. For East Germany RIF regressions illustrated that the positive mean effect for workers under individual contracting is associated with a large positive treatment effect at the bottom of the distribution and still positive yet lower effects further up the distribution, altogether decreasing wage dispersion. For blue-collar workers in the treated sectors under CA a generally positive effect of the MW can be observed yet with lower significance, just as in the OLS regressions.

[11] For comparison: In the pay scales the basic rate of pay *Ecklohn* is the lowest possible wage for a worker with the characteristics described above. RIF regressions turn significant at the 35%-percentile which refers to an hourly wage of roughly € 13. The basic wage rate amounted to € 12.75 at the time of the MW introduction.

Figure 2.2: RIF Coefficients of the Treatment Effect (DDD) on log Hourly Wages for East and West Germany



Notes: standard errors clustered on the establishment level in parentheses (3000 repetitions). Results from RIF regressions along the quantiles of the distribution of log hourly wages of the differences-in-differences-in-differences specification. "CA" refers to collective, firm or establishment agreement. For details on the specifications and full estimation output at selected quantiles refer to Table 2.9.

2.7 Conclusion

This study analyzes the impact of the introduction of the first sectoral MW in 1997 in Germany on hourly wages and their distribution. The reform was aimed at setting a lower wage floor for blue-collar workers in the construction sector but was not implemented across all sub-sectors due to institutional peculiarities in the wage bargain. I use this as a natural experiment to differentiate between treatment and control group on the 4-digit-industry classification level. Based on two cross sections of a linked employer-employee data set, the GSES, blue-collar workers in non-treated parts of the construc-

tion industry and white-collar workers serve as control groups in the differences-in-differences-in-differences regression framework. Unconditional quantile (RIF) regression complements estimated mean effects and gauges the impact heterogeneity along the wage distribution.

Descriptive results reveal that the MW bit strongly in East Germany reducing inequality particularly in the bottom of the distribution. Estimation results confirm that blue-collar workers in the covered sectors in East Germany benefitted most from the MW policy. There was no significant mean impact for employees in West Germany and those paid under CA in both parts of the country. Along the distribution the wage-increasing effect of the MW is highest in the bottom quarter of employees under individual bargaining in East Germany. While the distribution is bunched up from below the positive effect does not disappear entirely along the wage distribution. The prototypical union's median voter paid according to the CA also benefitted from a wage increase keeping his distance from the low paid. Overall these spill-overs mitigate the increase in equality in the lower ranks of the distribution again. No effect on hour of work is found and no substitution between the low productivity workers by their more skilled colleagues is found in terms of work hours.

Altogether these results suggest that the introduction of the MW had a sizable impact on wages and distribution of blue-collar workers in the treated sectors, particularly in East Germany, without any detectable change to skill input intensities. But the effect did not take place homogeneously across the wage distribution and the pay scheme. Apart from sizable spillover effects, evidence for West Germany points to the fact that the introduction of the MW also affected wages of those paid under a collective, firm or establishment agreement, despite the fact that the nominal pay scale was not bound by the MW. The pivotal role played by unions in the setting of the MW and the strive to maintain to wage hierarchies and/or the collective bargaining wage premium may serve as explanations for this somewhat unexpected result. The identification of the particular mechanisms in the interaction of wage bargaining and MWs are beyond the scope of this study but pose interesting questions for future research in economic theory as much as empirical work. The MW benefitted the lowest paid and reduced inequality in the lower part of the wage distribution but also fed trough to others that were initially not addressed by the policy.

2.8 Appendix

Table 2.8: Summary of effects from differences-in-differences-in-differences RIF regressions for East and West Germany

		q10	q20	q30	q40	q50	q60	q70	q80	q90
East	w/o CA	0.210***	0.195***	0.103***	0.104***	0.080***	0.076***	0.111***	0.124***	0.156
		(0.054)	(0.039)	(0.034)	(0.035)	(0.031)	(0.029)	(0.034)	(0.044)	(0.121)
	with CA	0.124*	0.124*	0.104*	0.161*	0.149*	0.173***	0.173**	0.205**	0.164
		(0.075)	(0.074)	(0.062)	(0.063)	(0.059)	(0.054)	(0.072)	(0.093)	(0.265)
West	w/o CA	0.032	0.026	0.017	0.031	0.038	0.023	0.028	0.061	0.143
		(0.053)	(0.034)	(0.024)	(0.022)	(0.024)	(0.028)	(0.035)	(0.064)	(0.108)
	with CA	0.018	0.021	0.000	0.054***	0.098***	0.099***	0.101***	0.099**	−0.068
		(0.027)	(0.021)	(0.019)	(0.018)	(0.021)	(0.023)	(0.030)	(0.050)	(0.074)

Source: GSES 1995 and 2001.
Notes: standard errors clustered on the establishment level in parentheses (3000 repetitions). ***significant at 1% level, **significant at 5% level, *significant at 10% level. Results from RIF regressions along the quantiles of the distribution of log hourly wages of the differences-in-differences-in-differences specification differentiated along whether wage was agreed upon in some kind of a collective, firm or establishment agreement or not (DDD-CA). "CA" refers to collective, firm or establishment agreement. Refer to Table 2.9 for full regression output at selected quantiles.

Table 2.9: Differences-in-differences-in-differences results in the RIF framework

	East Germany			West Germany		
	q25	q50	q75	q25	q50	q75
Blue*post*sector	0.128***	0.080***	0.111***	0.027	0.038	0.045
	(0.036)	(0.031)	(0.037)	(0.029)	(0.024)	(0.048)
Blue*post*sector*CA	0.009	0.068	0.069	−0.021	0.059*	0.067
	(0.079)	(0.070)	(0.087)	(0.036)	(0.032)	(0.058)
Blue*post*CA	−0.141*	−0.079	−0.028	−0.004	−0.023	−0.049
	(0.075)	(0.064)	(0.077)	(0.026)	(0.024)	(0.047)
Blue*sector*CA	0.096***	0.123***	0.083**	0.042	−0.008	−0.087**
	(0.031)	(0.028)	(0.037)	(0.026)	(0.021)	(0.044)
Post*sector*CA	−0.055	−0.057	0.005	0.026	0.016	−0.005
	(0.045)	(0.042)	(0.071)	(0.021)	(0.020)	(0.048)
Blue*CA	0.055**	−0.002	−0.078**	−0.039**	−0.033**	0.004
	(0.026)	(0.024)	(0.034)	(0.019)	(0.016)	(0.037)
Post*CA	0.028	0.010	−0.018	−0.007	−0.001	0.060
	(0.042)	(0.038)	(0.065)	(0.019)	(0.017)	(0.042)
Sector*CA	−0.024	0.007	−0.003	−0.024*	−0.012	0.024
	(0.020)	(0.020)	(0.033)	(0.013)	(0.013)	(0.033)
Blue*post	0.016	−0.043*	−0.100***	0.051***	0.035**	−0.012
	(0.026)	(0.023)	(0.027)	(0.019)	(0.016)	(0.034)
Blue*sector	−0.016	−0.039**	−0.111***	−0.001	−0.007	−0.058
	(0.023)	(0.019)	(0.022)	(0.023)	(0.017)	(0.037)
Post*sector	−0.043*	−0.032	−0.068**	−0.002	−0.001	−0.022
	(0.023)	(0.022)	(0.034)	(0.015)	(0.015)	(0.037)
Blue	−0.167***	−0.203***	−0.311***	−0.090***	−0.177***	−0.544***
	(0.019)	(0.016)	(0.022)	(0.015)	(0.013)	(0.033)
Post	0.073***	0.082***	0.116***	0.025**	0.026**	0.034
	(0.019)	(0.018)	(0.026)	(0.013)	(0.012)	(0.030)
Sector	0.083***	0.074***	0.134***	0.017	0.011	0.085***
	(0.016)	(0.015)	(0.021)	(0.011)	(0.011)	(0.027)
With CA	0.077***	0.080***	0.117***	0.045***	0.024**	−0.045
	(0.018)	(0.017)	(0.030)	(0.011)	(0.011)	(0.030)
Low-skilled	−0.180***	−0.239***	−0.335***	−0.295***	−0.239***	−0.290***
	(0.011)	(0.012)	(0.015)	(0.008)	(0.007)	(0.011)
Female	−0.110***	−0.116***	−0.250***	−0.085***	−0.117***	−0.391***
	(0.008)	(0.008)	(0.011)	(0.005)	(0.005)	(0.014)
Age	0.017***	0.014***	0.007***	0.021***	0.015***	0.012***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Age*age	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Medium-skilled	−0.073***	−0.097***	−0.206***	−0.045***	−0.101***	−0.191***
	(0.007)	(0.009)	(0.013)	(0.003)	(0.004)	(0.008)
Full-time	0.117***	0.094***	0.103***	0.054***	0.030***	0.058***
	(0.016)	(0.014)	(0.014)	(0.009)	(0.007)	(0.012)
Tenure in months	0.000***	0.000***	0.000	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
20<size≤50	0.029**	0.016	0.008	0.022***	0.024***	0.037***
	(0.014)	(0.011)	(0.010)	(0.007)	(0.007)	(0.010)
50<size≤100	0.044***	0.023*	0.011	0.033***	0.041***	0.075***
	(0.016)	(0.013)	(0.012)	(0.008)	(0.007)	(0.011)
100<size≤200	0.061***	0.043***	0.027*	0.032***	0.047***	0.085***
	(0.015)	(0.013)	(0.014)	(0.007)	(0.007)	(0.010)
Size>200	0.091***	0.093***	0.067***	0.057***	0.069***	0.117***
	(0.016)	(0.016)	(0.017)	(0.008)	(0.008)	(0.011)
Constant	1.714***	2.043***	2.548***	2.051***	2.418***	2.946***
	(0.038)	(0.028)	(0.030)	(0.024)	(0.019)	(0.034)
R^2	0.273	0.349	0.414	0.280	0.356	0.478
N	27,640	27,640	27,640	53,651	53,651	53,651
Blue*post*sector*CA	0.137	0.149**	0.181**	0.006	0.098**	0.112**
+ Blue*post*sector	(0.067)	(0.059)	(0.079)	(0.020)	(0.021)	(0.036)

Source: GSES 1995 and 2001.
Notes: standard errors clustered on the establishment level in parentheses (3000 repetitions). ***significant at 1% level, **significant at 5% level, *significant at 10% level. The dependent variable is log hourly wages. The reference category for establishment size variables ("# <size≤ #") is 20 or less employees. "CA" refers to collective, firm or establishment agreement. Results from RIF regressions of the differences-in-differences specification differentiated along union status at the 25th, 50th and 75th quantile. See specification "DDD-CA" in Tables 2.11 & 2.10 for the least squares analogues.

Table 2.10: Detailed differences-in-differences-in-differences estimation results for wages in East Germany

	all	all	placebo II	no firm CA	no large firms	no foremen
Blue*post*sector	0.080	0.130	0.003	0.130	0.109	0.136
	(0.028)	(0.036)	(0.063)	(0.036)	(0.038)	(0.038)
Blue*post*sector*CA		−0.013	−0.080	−0.030	0.004	−0.016
		(0.076)	(0.098)	(0.083)	(0.079)	(0.078)
Blue*post*CA		−0.083	0.033	−0.065	−0.057	−0.085
		(0.068)	(0.070)	(0.076)	(0.071)	(0.071)
Blue*sector*CA		0.087	−0.090	0.085	0.059	0.090
		(0.029)	(0.045)	(0.029)	(0.030)	(0.030)
Post*sector*CA		0.008	−0.018	−0.001	0.008	0.011
		(0.075)	(0.081)	(0.079)	(0.064)	(0.079)
Blue*CA		−0.034	0.059	−0.032	−0.026	−0.029
		(0.025)	(0.038)	(0.025)	(0.026)	(0.026)
Post*CA		0.004	0.015	0.013	−0.028	0.006
		(0.066)	(0.063)	(0.070)	(0.054)	(0.070)
Sector*CA		−0.006	0.114	−0.001	0.039	−0.009
		(0.029)	(0.045)	(0.029)	(0.029)	(0.032)
Blue*post	−0.098	−0.093	−0.118	−0.093	−0.092	−0.093
	(0.023)	(0.027)	(0.051)	(0.027)	(0.028)	(0.028)
Blue*sector	−0.095	−0.145	0.084	−0.144	−0.129	−0.162
	(0.013)	(0.020)	(0.034)	(0.020)	(0.021)	(0.022)
Post*sector	−0.064	−0.071	−0.102	−0.072	−0.050	−0.077
	(0.032)	(0.037)	(0.061)	(0.037)	(0.039)	(0.039)
Blue	−0.296	−0.280	−0.314	−0.280	−0.282	−0.279
	(0.012)	(0.016)	(0.031)	(0.017)	(0.018)	(0.018)
Post	0.154	0.153	0.278	0.154	0.153	0.154
	(0.026)	(0.029)	(0.047)	(0.029)	(0.029)	(0.030)
Sector	0.175	0.181	0.013	0.181	0.163	0.198
	(0.015)	(0.020)	(0.035)	(0.020)	(0.021)	(0.022)
With CA	0.111	0.110	−0.017	0.109	0.098	0.104
	(0.008)	(0.025)	(0.038)	(0.025)	(0.025)	(0.028)
Female	−0.296	−0.295	−0.190	−0.296	−0.306	−0.300
	(0.008)	(0.008)	(0.013)	(0.009)	(0.010)	(0.009)
Age	0.014	0.014	0.017	0.013	0.014	0.014
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
Age*age	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Low-skilled	−0.303	−0.306	−0.308	−0.311	−0.313	−0.304
	(0.010)	(0.010)	(0.015)	(0.010)	(0.010)	(0.010)
Medium-skilled	−0.187	−0.191	−0.209	−0.194	−0.195	−0.190
	(0.008)	(0.008)	(0.011)	(0.008)	(0.008)	(0.008)
Full-time	0.152	0.152	0.157	0.153	0.141	0.152
	(0.014)	(0.014)	(0.024)	(0.014)	(0.015)	(0.014)
Tenure in months	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
20<size≤50	0.023	0.025	0.006	0.025	0.024	0.025
	(0.011)	(0.011)	(0.015)	(0.011)	(0.011)	(0.011)
50<size≤100	0.033	0.034	0.033	0.036	0.030	0.036
	(0.012)	(0.012)	(0.017)	(0.012)	(0.012)	(0.012)
100<size≤200	0.053	0.052	0.068	0.049	0.046	0.052
	(0.013)	(0.013)	(0.023)	(0.013)	(0.013)	(0.013)
Size>200	0.097	0.093	0.137	0.101		0.094
	(0.015)	(0.015)	(0.030)	(0.015)		(0.015)
Constant	2.145	2.151	2.042	2.156	2.155	2.145
	(0.026)	(0.028)	(0.049)	(0.028)	(0.030)	(0.028)
R^2	0.579	0.585	0.491	0.591	0.548	0.571
N	27,640	27,640	13,407	26,903	21,986	26,873

Source: GSES 1995 and 2001.

Notes: standard errors clustered on the establishment level in parentheses. ***significant at 1% level, **significant at 5% level, *significant at 10% level. The dependent variable is log hourly wages. The reference category for establishment size variables ("# <size≤ #") is 20 or less employees. CA refers to collective, firm or establishment agreement. "DDD-CA" stands for least squares estimation of the differences-in-differences-in-differences specification differentiated along union status. "<200" restricts the sample to observations in establishments with up to 200 employees; "no firm CA" estimates based on all observations except for those under firm or establishment level agreements; "no foremen" excludes foremen and head masons from the white-collar workers control group.

Table 2.11: Differences-in-differences-in-differences estimation results for wages in West Germany

	all	all	placebo II	no firm CA	no large firms	no foremen
Blue*post*sector	0.017	0.056	0.017	0.056	0.055	0.056
	(0.020)	(0.038)	(0.042)	(0.038)	(0.040)	(0.041)
Blue*post*sector*CA		−0.024	−0.014	−0.022	−0.046	−0.022
		(0.044)	(0.054)	(0.044)	(0.044)	(0.047)
Blue*post*CA		−0.068	−0.058	−0.069	−0.020	−0.081
		(0.033)	(0.042)	(0.033)	(0.030)	(0.035)
Blue*sector*CA		0.074	−0.103	0.075	0.070	0.086
		(0.030)	(0.037)	(0.030)	(0.033)	(0.032)
Post*sector*CA		0.059	−0.064	0.056	0.061	0.056
		(0.040)	(0.043)	(0.041)	(0.040)	(0.044)
Blue*CA		0.050	0.151	0.050	0.004	0.058
		(0.023)	(0.031)	(0.023)	(0.022)	(0.023)
Post*CA		0.051	0.112	0.054	0.011	0.064
		(0.032)	(0.029)	(0.032)	(0.029)	(0.034)
Sector*CA		−0.083	0.018	−0.084	−0.062	−0.095
		(0.027)	(0.029)	(0.027)	(0.030)	(0.028)
Blue*post	−0.003	0.037	0.021	0.037	−0.009	0.050
	(0.018)	(0.027)	(0.031)	(0.027)	(0.027)	(0.029)
Blue*sector	−0.050	−0.123	0.054	−0.123	−0.105	−0.143
	(0.013)	(0.028)	(0.030)	(0.028)	(0.031)	(0.030)
Post*sector	0.035	−0.030	−0.006	−0.030	−0.027	−0.030
	(0.020)	(0.036)	(0.037)	(0.036)	(0.038)	(0.039)
Blue	−0.315	−0.347	−0.358	−0.347	−0.306	−0.353
	(0.011)	(0.020)	(0.024)	(0.020)	(0.020)	(0.021)
Post	0.039	0.013	0.028	0.013	0.062	−0.000
	(0.018)	(0.027)	(0.025)	(0.026)	(0.027)	(0.029)
Sector	0.047	0.124	0.013	0.124	0.110	0.144
	(0.012)	(0.026)	(0.025)	(0.026)	(0.028)	(0.028)
With CA	−0.037	−0.064	−0.090	−0.064	−0.024	−0.071
	(0.006)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Female	−0.274	−0.271	−0.190	−0.272	−0.282	−0.276
	(0.007)	(0.007)	(0.006)	(0.007)	(0.008)	(0.008)
Age	0.016	0.016	0.021	0.016	0.017	0.016
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Age*age	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Low-skilled	−0.293	−0.290	−0.296	−0.290	−0.280	−0.289
	(0.006)	(0.006)	(0.013)	(0.006)	(0.006)	(0.006)
Medium-skilled	−0.142	−0.140	−0.171	−0.140	−0.127	−0.138
	(0.004)	(0.004)	(0.009)	(0.004)	(0.004)	(0.004)
Full-time	0.119	0.121	0.117	0.122	0.132	0.121
	(0.011)	(0.011)	(0.013)	(0.011)	(0.013)	(0.011)
Tenure in months	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
20<size≤50	0.033	0.033	0.038	0.033	0.031	0.033
	(0.007)	(0.007)	(0.010)	(0.007)	(0.007)	(0.007)
50<size≤100	0.058	0.056	0.059	0.057	0.051	0.056
	(0.008)	(0.008)	(0.012)	(0.008)	(0.008)	(0.008)
100<size≤200	0.062	0.060	0.094	0.061	0.056	0.060
	(0.007)	(0.007)	(0.010)	(0.007)	(0.007)	(0.007)
Size>200	0.089	0.087	0.153	0.088		0.087
	(0.008)	(0.008)	(0.011)	(0.008)		(0.008)
Constant	2.499	2.513	2.369	2.512	2.439	2.518
	(0.022)	(0.026)	(0.031)	(0.026)	(0.028)	(0.027)
R^2	0.569	0.572	0.523	0.572	0.536	0.561
N	53,651	53,651	36,413	53,525	36,939	51,680

Source: GSES 1995 and 2001.

Notes: standard errors clustered on the establishment level in parentheses. ***significant at 1% level, **significant at 5% level, *significant at 10% level. The dependent variable is log hourly wages. The reference category for establishment size variables ("# <size≤ #") is 20 or less employees. CA refers to collective, firm or establishment agreement. "DDD-CA" stands for least squares estimation of the differences-in-differences-in-differences specification differentiated along union status. "<200" restricts the sample to observations in establishments with up to 200 employees; "no firm CA" estimates based on all observations except for those under firm or establishment level agreements; "no foremen" excludes foremen and head masons from the white-collar workers control group.

Table 2.12: OLS Differences-in-Differences-in-Differences Results for Hours

	East Germany				West Germany		
	(1) all	(2) no firm CA	(3) placebo II	(4) all	(5) all	(6) placebo	(7) all
Blue*post*sector	0.002	0.002	-0.003	0.002	0.009	0.003	0.009
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.007)	(0.006)
Blue*post*sector*LS				0.000			0.001
				(0.011)			(0.008)
Blue*post*LS				0.003			-0.002
				(0.010)			(0.007)
Blue*sector*LS				0.000			0.004
				(0.003)			(0.004)
Post*sector*LS				0.001			0.001
				(0.009)			(0.006)
Blue*LS				-0.001			-0.003
				(0.002)			(0.004)
Post*LS				-0.003			-0.001
				(0.008)			(0.005)
Sector*LS				0.002			-0.005
				(0.003)			(0.003)
Blue*post	-0.003	-0.003	0.002	-0.003	-0.003	-0.008	-0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)
Blue*sector	-0.002	-0.002	-0.003	-0.002	-0.012	0.010	-0.013
	(0.001)	(0.001)	(0.002)	(0.001)	(0.004)	(0.004)	(0.004)
Post*sector	-0.002	-0.002	0.010	-0.003	-0.009	0.005	-0.009
	(0.005)	(0.005)	(0.006)	(0.005)	(0.007)	(0.008)	(0.007)
Blue	0.002	0.002	0.004	0.002	0.011	0.001	0.011
	(0.001)	(0.001)	(0.002)	(0.001)	(0.004)	(0.002)	(0.004)
Post	0.000	0.000	-0.013	0.001	0.007	-0.005	0.007
	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)	(0.005)	(0.007)
Sector	-0.004	-0.004	-0.012	-0.004	0.037	0.012	0.038
	(0.002)	(0.002)	(0.003)	(0.002)	(0.005)	(0.005)	(0.005)
With CA	-0.011	-0.012	-0.014	-0.011	-0.007	-0.028	-0.007
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.003)	(0.002)
Female	-0.001	-0.001	-0.001	-0.001	-0.003	-0.002	-0.003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Age	0.000	0.000	0.000	0.000	-0.000	-0.001	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age*age	-0.000	-0.000	-0.000	-0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Low-skilled	-0.001	-0.001	0.000	-0.002	0.001	-0.002	0.005
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.003)
Medium-skilled	-0.000	0.000	0.003		0.001	-0.000	
	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	
Tenure in months	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
20<size≤50	0.000	0.000	-0.002	0.000	-0.002	-0.001	-0.002
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
50<size≤100	-0.001	-0.002	-0.003	-0.001	-0.002	-0.013	-0.002
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.004)	(0.002)
100<size≤200	-0.004	-0.004	-0.005	-0.004	-0.004	-0.016	-0.004
	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.003)	(0.002)
Size>200	-0.007	-0.007	-0.011	-0.007	-0.009	-0.030	-0.009
	(0.002)	(0.002)	(0.004)	(0.002)	(0.003)	(0.004)	(0.003)
Constant	5.141	5.141	5.152	5.141	5.104	5.128	5.104
	(0.003)	(0.003)	(0.005)	(0.003)	(0.006)	(0.006)	(0.005)
R^2	0.103	0.109	0.138	0.103	0.131	0.239	0.131
N	27,123	26,388	13,036	27,123	51,623	34,193	51,623

Source: GSES 1995 and 2001.
Notes: Refer to Table 2.6 for general details. LS refers to low skilled workers (no vocational training.)

Table 2.13: Descriptive statistics for East and West Germany

		Treated Sectors				Control Sectors			
		Blue-collar		White-collar		Blue-collar		White-collar	
		Before MW	After MW	Before MW	After MW	Before MW	After MW	Before MW	After MW
East Germany	Average establishment size	43	31	46	33	28	19	29	20
	Percentage under (collective) agreement	54%	33%	54%	35%	40%	18%	41%	11%
	Percentage female	0%	0%	44%	37%	1%	1%	49%	49%
	Percentage working full-time	100%	98%	93%	89%	100%	99%	90%	83%
	Average Age	37	39	42	43	36	38	41	43
	Fraction low-skilled	30%	27%	14%	13%	15%	11%	22%	22%
	Fraction medium-skilled	59%	60%	55%	54%	73%	73%	47%	51%
	Average tenure in months	72	76	89	98	76	76	91	90
	Average hourly wage	9.93	10.48	14.36	15.90	9.03	9.32	11.56	12.85
	Average contracted monthly hours	169	168	166	161	171	171	166	158
	Number of employees (unweighted)	11595	3871	2886	983	4646	1902	1229	528
	Number of establishments (unweighted)	533	185	511	173	312	126	300	121
West Germany	Average establishment size	40	37	44	37	22	20	22	20
	Percentage under (collective) agreement	92%	77%	80%	58%	69%	53%	54%	40%
	Percentage female	0%	0%	32%	32%	2%	2%	47%	48%
	Percentage working full-time	100%	98%	90%	87%	99%	97%	85%	73%
	Average age	41	41	42	43	37	38	41	42
	Fraction low-skilled	26%	27%	15%	17%	16%	22%	22%	32%
	Fraction medium-skilled	50%	50%	49%	43%	55%	51%	50%	41%
	Average tenure in months	112	109	133	122	108	111	137	122
	Average hourly wage	13.13	14.29	18.48	20.79	12.95	13.51	16.22	16.83
	Average contracted monthly hours	168	167	161	157	164	163	153	141
	Number of employees (unweighted)	18,254	9,512	6,275	3,394	5,956	5,605	2,173	2,482
	Number of establishments (unweighted)	719	460	679	456	391	393	375	392

Notes: The calculations are weighted unless stated otherwise.
Source: GSES 1995 and GSES 2001.

Chapter 3

Sharing the burden: Empirical evidence on corporate tax incidence

3.1 Introduction

The issue of who effectively bears the burden of the corporate income tax (CIT) has not been settled so far, whether by theory or empirical work (for a review of tax incidence in general, see Fullerton and Metcalf (2002).[1] For many policy makers, CIT revenues constitute not only government income and a safeguard for personal income taxation, but also an important means to increase the progressivity of the tax system. This view would hold true if capital owners were generally wealthier and capital effectively bore the full tax burden. Yet this latter point is heavily contested; if labor instead of capital actually bears the lion's share of the CIT burden, the role of corporate taxation within the tax system and in the wage setting process must be revisited. Identifying who actually pays for CIT thus is not only a highly relevant topic in economic research but is equally important for policy makers.

The literature distinguishes between two pathways through which taxes on corporate income are passed onto workers by lowering their wage rates. First, in a general equilibrium concept, the corporate income tax distributes capital between the taxed corporate sector and an untaxed sector and leads capital to bear the full burden given the

[1] This chapter is based on joint work with Viktor Steiner and Nadja Dwenger.

assumptions of equal elasticities of substitution and initial factor endowments in a closed economy (Harberger, 1962).

A couple of recent empirical studies contest this finding; they agree that corporate taxes exert a negative effect on wage rates but offer widely varying estimates of the size of the effects. Second, and this will be the focus of our study, the CIT affects the wage rate through bargaining over economic rents. We consider an environment with firms that are able to make positive profits and unions that bargain wage rates for all employees. Then a change in corporate income taxation affects the bargaining outcome, as the CIT reduces the profit workers and firm owners can bargain over.

Our study contributes to the literature by providing estimates of corporate tax incidence based on a new data set addressing several important methodological issues and the question how incidence should best be measured. We argue that previous literature has neglected essential factors in assessing the true tax burden on labor. As other studies in the field we presume collective bargaining to take place in a "right-to-manage" setting, where wage rates are negotiated over, with the firm retaining the right to adjust its labor force after wage rates are set (Nickell and Andrews, 1983). We consider the effect of corporate taxes for the wage bargaining result and the subsequent employers' decision about labor demand ("wage bargaining effect"). Studies so far only considered the bargaining result and its effect on the wage rate but neglected the ensuing employment effect. As the change in employment finally feeds into the wage bill it may potentially offset the effect on wage rates. We furthermore take into account that corporate taxes influence the user cost of capital and thus additionally alter the capital stock and the relative price of input factors ("user cost of capital effect"). We argue that only the combination of both effects reveals the true overall burden of corporate taxes on labor.

Second, we measure the tax burden at the corporate level using firm-specific average tax rates (ATR). The ATR varies over time and across firms because of two substantial tax reforms, the Tax Relief Act and the Tax Preference Reduction Act, affecting firms heterogeneously and because of the considerable divergence in tax shields across firms, such as the amount of unused loss carry-forward, which has increased dramatically in Germany.[2] As the ATR is likely endogenous with regard to wage rate decisions

[2]The implications of the asymmetric treatment of tax losses in the United States are the focus of a recent study by Altshuler et al. (2009). They find that tax rate differentials are particularly significant if firms use debt financing or investment tax credits.

(Gruber, 1997) we control for the potential endogeneity bias in estimated empirical wage equations with a counterfactual ATR as an instrumental variable. We define this counterfactual ATR as the tax rate a corporation would have faced in a particular period, had it not responded to the reform (Gruber and Saez, 2002). The counterfactual ATR derives from a microsimulation model developed on the basis of detailed tax return data.

Third, we use a rich data set that combines comprehensive tax return data and labor market variables, based on the full record of employees on the Social Security payroll in Germany during the period 1998 through 2006. This unique data set offers two advantages: broad coverage and detailed tax information also needed to construct our instrument. The underlying national labor market institutions influence how corporate taxes may affect employment and wages. The German case is most interesting as it allows us to analyze the effects of corporate taxation in a labor market characterized by collective bargaining. Moreover, our results are based on the variation in actual tax return and labor market data collected on the micro-level, as opposed to the majority of studies in the field that use cross-country variation and thus measure tax incidence for the average of different institutional settings present in the national labor market and tax legislations.

Our preferred instrumental variable estimation reveals that a one percentage point increase in the ATR reduces wages by 2.37% in the long run. Based on this long-run semi-elasticity and accounting for the effects of wage bargaining and changes in user cost of capital on employment, our incidence calculations show that an increase of corporate tax revenue by € 1 would reduce the wage bill by € 0.47; labor thus bears a little more than half of the burden of the CIT. If a conventional approach to estimate incidence without correcting for employment was followed, we would find that wage bargaining leads to a full shift of the burden of the CIT on labor (point estimate of € 1.56, which is statistically not different from € 1 at the 5% significance level), a magnitude in line with prior literature. The discrepancy between calculations with and without accounting for employment effects underlines the importance of a broader perspective on incidence calculations than applied in previous literature.

In the next section, we provide a concise overview of previous results, both theoretical and empirical, in literature related to corporate tax incidence. In Section 3.3 we explain the different channels that affect the overall elasticity of the wage bill with

regard to corporate taxes. Section 3.4.1 outlines the institutions of the German CIT system and the main changes to the system induced by recent tax reforms. As we show in Section 3.4.2, regulation changes had differential impacts across firms and introduced exogenous variation in the ATR. Section 3.4.3 contains our estimation strategy, and Section 3.5 illustrates our data set. In Section 3.6.1, we report the incidence results when we do not account for employment; in Section 3.6.2, we present the estimation results and incidence calculations when we account for employment effects. Section 3.7 summarizes our main results and concludes.

3.2 Previous literature

Wage differentials across industries are substantial and cannot be fully explained by differences in firm size, productivity, regional variation or job characteristics (e.g., Krueger and Summers (1988)); patterns of industry wage differentials are also found to be similar for workers in different occupations (Dickens and Katz, 1987). Several studies set out to test empirically whether rent-sharing theories are a better description of labor markets than the standard competitive model (e.g., Christofides and Oswald (1992); Blanchflower et al. (1996); Hildreth and Oswald (1997)). They find that past profitability increases real wages, a result that lends support to the rentsharing hypothesis. Recently Krautheim and Schmidt-Eisenlohr (2011) developed a model of international tax competition where the tax burden may be shifted disproportionally onto wages as firms can opt to shift profits abroad, effectively reducing the after-tax surplus shared between workers and shareholders. These findings suggest that employees participate in the economic rents of the firm and by means of rent-sharing the CIT affects wage rates: an increase (decrease) in CIT rates reduces (enlarges) the pie over which workers and employers can bargain.

Arulampalam et al. (2009, 2010) were the first to study what they call the "direct" incidence of CIT through wage bargaining, as opposed to "indirect" incidence of CIT through adjustments in capital stock or output prices. In an efficient bargain bargaining model, a single union and a firm bargain over the firm's rent, contingent on corporate taxes. Using firm-level data from nine European countries (1996 through 2005), the authors identify the impact of CIT rates on total compensation per worker by varying

the tax liability per employee. By conditioning in their estimations on value added per worker the authors claim to measure exclusively the impact of corporate taxes on the wage rate while holding all other activities of the company - including employment - fixed. The incidence (elasticity) estimate of the CIT's impact on the wage rate thus refers to the effect of a \$1 (1%) increase of tax liability on total compensation paid in the average firm. Arulampalam et al. report an elasticity with respect to the CIT rate of -0.12 (-0.09) in the short (long) run. The associated incidence results hinge on whether they are calculated at the mean or the median firm; in the long run, neglecting adjustments in employment, labor bears between 49% (mean) and 92% (median) of a tax increase.[3]

For the sake of completeness, we also briefly review the literature on the traditional "indirect" incidence, even though this strand of literature is based on an approach to CIT incidence quite different from the focus of our study. The canonical literature on CIT incidence studies CIT effects on labor that arise because of changes in prices and demand for capital and labor triggered by a tax reform. The key theoretical contribution on this strand of the literature is the two-sector general equilibrium model developed by Harberger (1962). In a closed economy with a fixed, immobile supply of labor and capital, split between a corporate and a non-corporate sector, a tax gets implemented in the first sector. Under a plausible set of assumptions, capital owners in both sectors bear close to or even more than 100% of the tax burden. Several similar studies have added other features to the model, such as more sub-sectors, 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.

Harberger's (Harberger, 1995) own extensions of his model reverse the incidence result. In the context of an open economy with free capital flows yet an immobile labor force, labor may bear the full burden under certain assumptions (cf. Bradford (1978); Kotlikoff and Miao (2010)). Gravelle (2010) takes stock of four model variations (Grubert and Mutti, 1985; Gravelle and Smetters, 2006; Randolph, 2006; Harberger, 2008) that cast light on CIT incidence in an open-economy setting. She also identifies five driv-

[3]The authors precede their empirical analysis with a theoretical section featuring an efficient wage bargaining model, where a single union and a firm bargain over the firm's rent, contingent on corporate taxes. The empirical part, however, does not correspond fully to the efficient wage bargaining model as it abstracts from the first-order condition of employment.

ing forces that determine the share of the burden falling on labor and capital, according to these models: the degree of capital mobility, the degree of international product substitution, the size of the country, the degree of factor substitution, and how much greater capital intensity is in the taxed sector. The share of the tax burden attributed to labor in these studies covers a wide range of alternative combinations of assumptions, such that labor might bear virtually no burden or more than 100% of it.

Several empirical studies have attempted to quantify the burden of the CIT shifted onto labor through changes in capital stock or output prices. Most of these studies use some variation on the country-year level to identify the impact of the CIT rate on wage rates. Hassett and Mathur (2006) focus on manufacturing wages in a panel covering 72 countries and 22 years. According to their estimates, a 1% increase in the top CIT rate is associated with a decline of wages by 0.8% to 1%. These results imply that an increase in the CIT by $1 would decrease the wage bill by $22 to $26 (Gravelle, 2010). In an update, using a panel of 65 countries over 25 years, Hassett and Mathur (2010) find an elastic wage rate with respect to the corporate tax rate of -0.5 to -0.6. These estimates suggest that a $1 increase in the tax revenue leads to a nearly $3 to $4 decrease in the real wage. Desai et al. (2007) estimate a CIT incidence of 45% to 69%, based on a panel of U.S. multinational firms' activities abroad. All these cross-country studies have been challenged on grounds of data quality, and some may also feature implausibly high incidence calculations (see Gravelle (2010)).

Felix (2007) estimates a random effects model based on the Luxemburg Income Study, spanning 1979 through 2002. She finds a semi-elasticity of -0.92 of annual gross wages, given a change in the average corporate tax rate. In the incidence calculation based on aggregate values of CIT revenues and total wages, this estimate would imply that $1 more tax revenue reduces the total wage bill by $4.2.

Evaluating the German Business Tax reform of 2000 using a difference-in-differences approach and French manufacturing companies as counterfactual examples, aus dem Moore et al. (2010) find a significant and positive wage effect of the reform; their estimate suggests that wages were 6.4% higher on average after the reduction in CIT rates.

Liu and Altshuler (2011) combine three cross-sections of Current Population Survey (CPS) data (1982, 1992, and 1997) with capital flows data from the Bureau of Economic Analysis and concentration ratio data from the Economic Census to study tax incidence

under imperfect competition. The identification comes from variation in the effective marginal tax rates by industry, as a weighted average of the effective marginal tax rates by asset. She finds that the elasticity of (weekly) wages with respect to the CIT is around -0.042 under imperfect competition. Incidence calculations based on industry-level estimation results suggest that an increase in total CIT revenue by $1 reduces labor income by $0.89, if employment and hours worked remain unchanged. Also drawing on the CPS Felix and James R. Hines (2009) use the variation in the highest marginal corporate tax rates across U.S. states from 1977 to 2005 to identify the impact of the CIT on wages. In a regression that does not include individual or federal state fixed effects, she finds that a one percentage point increase in the marginal corporate tax rate is associated with a decline in wages of between 0.17% and 0.36%.

Estimates of the semi-elasticities in these studies vary widely, and incidence estimates for the burden on labor are between $0.45 and $4.20. Several reasons, including the data quality, level of analysis, measure of tax rates, potential endogeneity of the tax rate,[4] and the difficulty to capture mediated effects on the wage bill through adjustments in the workforce, may explain the great divergence of results and implausible magnitudes of some incidence estimates. It seems noteworthy that none of these studies explicitly takes into account employment effects in the calculation of tax incidence, which is a major focus of our study.

However, a recent study by Corseuil and Moura (2010) suggests that there are tax effects on employment, making the strong and contestable assumption that wage rates remain unaffected by a change in taxes. They examine the effects of taxes on employment in Brazil, where a tax incentive program for small businesses reduced the monetary and administrative costs for micro-firms, which could opt to participate if their annual gross revenue in the previous year did not exceed a given threshold and report a positive employment effect of 6% to 7.5% of the average employment level in the sample. As they show, this employment effect can be decomposed into two elements: decreased firm exits among firms that opted for the program, and increased employment due to improved tax conditions.

[4]For instance, cross-country differences in wage setting institutions might correlate with tax rate differentials that are not controlled for in the estimation.

3.3 Capturing Incidence

In our study we consider the shifting of the CIT burden in the theoretical framework of wage bargaining. We assume that the collective bargaining process follows a "right-to-manage" model, with the firm retaining the right to adjust its labor force after wage rates were set (Nickell and Andrews, 1983). Following the standard practice in the literature we assume that the employer gets zero profit if workers and the employer disagree in the wage bargaining process, and workers receive the level of utility of an unemployed person. Stylized facts for different countries lend somewhat more support to the right-to-manage model amongst the different wage bargaining models (Cahuc and Zylberberg, 2004, p. 429), and Layard et al. (1991) judge the right-to-manage model to describe fairly close the wage regime in countries with bargaining regimes representative for Germany.

In this model lower CIT rates increase the economic rents and lead, *ceteris paribus*, to higher bargained wage rates and, in turn, to a reduction in employment. Apart from this wage bargaining effect of corporate taxes on the wage bill, employers also experience a reduction in the user cost of capital (UCC) as a result of a CIT cut. UCC potentially affect input factor intensities and thus finally the level of employment and the wage bill, captured in the user cost of capital effect. In terms of elasticities, the relative change of the wage bill induced by a marginal change in ATR is given by:[5]

$$\begin{aligned}\eta_{\text{wage bill, ATR}} = &[1 + (\Delta\text{employment}/\Delta\text{wage rate}) \times (\text{wage rate}/\text{employment})] \\ &(\Delta\text{wage rate}/\Delta\text{ATR}) \times (\text{ATR}/\text{wage rate}) \\ &+ (\Delta\text{employment}/\Delta\text{UCC}) \times (\text{UCC}/\text{employment}) \times \\ &(\Delta\text{UCC}/\Delta\text{ATR}) \times (\text{ATR}/\text{UCC}) \\ = &\left[1 + \eta_{\text{employment, wage rate}}\right] \times \eta_{\text{wage rate, ATR}} + \eta_{\text{employment, UCC}} \times \eta_{\times UCC,ATR},\end{aligned} \tag{3.1}$$

where the first term refers to the wage bargaining effect and the second term to the user cost of capital effect.

[5] We implicitly assume that the average wage per employee changes proportionally to the average wage rate in the calculation of the empirical elasticities below.

3.4 Identification and estimation

The bargained wage depends, inter alia, on the level of economic rents to be distributed between the two parties and, hence, the average CIT rate, whereas the marginal effective corporate tax rate would affect wage determination in completely competitive labor markets. We calculate our measure of the ATR for each corporation as the ratio of the CIT assessed in a given year to the net profit before loss carry-over (NPBL, see Section 3.8.1), i.e., ATR = corporate tax assessed/NPBL.[6] The NPBL is derived from the tax return data by adding non-deductible expenses but deducting certain exemptions and allowable deductions to a corporation's profit, as shown in its tax balance sheet (see Section 3.8.1).[7] The ATR thus measures the percentage of pre-tax profits that has to be paid in taxes cutting the rent workers and firm owners can bargain over.

We identify the incidence of the CIT by relating CIT return data and social security information on the basis of a pseudo-panel. Our identification of the labor market effects of corporate taxation reflects changes to the CIT system introduced by the Tax Relief Act (1998 to 2001) and by a cap on the use of tax loss carry-forward, as introduced by the Tax Preference Reduction Act in 2004 (see 3.4.1). Differences in the amount of tax losses carried forward between firms and over time provide additional variation to identify tax incidence. In the estimations, we address three issues we consider pivotal for a clear identification of the effect of CIT rates on labor market outcomes. First, we account for the fact that firms can adjust their workforce once wage bargaining is completed. We argue that the hiring (firing) decision deserves particular attention, because any incidence calculation that does not consider employment effects of changes in wage rates must overestimate the burden on labor. Second, we measure ATR rates, which provide sufficient variation to identify tax incidence on the firm level with a full

[6]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.

[7]If NPBL equals 0 or is negative, the ATR is also 0. The ATR differs from the statutory rate, because tax credits for foreign-source income can be deducted in the calculation of the CIT assessed, and because of the difference between NPBL and taxable income, which is mainly driven by the corporation's loss carry-forward.

record of companies. And third, we account for the endogeneity of the ATR using an instrumental variable technique based on simulated tax rates.

3.4.1 The German CIT system and changes to CIT regulation between 1998 and 2004

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 schedules.[8] The assessment base of the CIT, or taxable income, can be derived from the amount of profits recorded in the tax balance sheet (see Section 3.8.1).[9] Until 2000, the German CIT system was based on the tax credit method, such that the amount of CIT assessed was credited against the personal income tax of the shareholder, and retained earnings were subject to a higher tax rate than distributed profits (McDonald, 2001).

The Tax Relief Act eliminated the imputation system in favor of a half-income method. Since 2001, the tax rate on corporate income has been uniform and does not depend on a corporation's payout ratio. According to the half-income method, CIT is definite, and half of the dividends are subjected to personal income tax.[10] In addition to significantly lowering the tax rate to 25% in 2001, the reform broadened the tax base; it

[8] Unlike in the United States, companies cannot easily shift income between corporate and individual tax bases but must change their legal form to do so.

[9] Corporations are liable for local business taxes, levied on an adjusted profit measure (which includes a share of interest payments on long-term debt and leasing costs) at a rate that varies across municipalities (for details, see Bach et al. (2008); Fossen and Bach (2008). In general, the local business tax paid by a corporation is a deductible expense. Because there was virtually no change in the local business tax in our observation period (except for asset-backed securities companies, introduction of the minimum taxation, and some minor changes to the rules on local business tax groups) and the municipality specific rates hardly changed (German Federal Statistical Office 1998, 2001, 2004), we ignore it in our ATR simulation. To simplify the analysis, we also do not include the solidarity surcharge, which was 5.5% in 1999, 2001, and 2004. As a proportional surcharge on the CIT assessed, its omission should not influence our results.

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

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

3.4.2 Exogenous variation in the ATR induced by the tax reforms

The tax reforms did not affect corporations equally, and we observe substantial variation in the changes of their ATRs. First, every year, approximately 20% of German corporations use a tax loss carry-forward or carry-back to offset their current profits. These corporations do not pay any CIT and thus have an ATR of 0, which has remained unaffected by changes in the statutory tax rate. The use of tax loss carry-forward is not at the corporation's discretion though, because unused tax loss carry-forward must be fully accounted for in current profits.

Second, the statutory tax rate and ATR in 1998 depended on the ratio between retained and distributed earnings: A corporation that completely abstained from the distribution of earnings was liable to a CIT rate of 45%, whereas one that distributed its whole profit was subjected to a CIT rate of only 30%. Splitting the tax rate is a specific feature of the tax credit method. Therefore, the reduction in the ATR was much greater for corporations that retained most of their earnings compared with corporations that distributed all their profits.

Third, some corporations were subject to reduced statutory CIT rates in 1998. Mutual insurance societies, private foundations, and business enterprises of public corporations benefited from a reduced tax rate of 42% in 1998. At the same time, a flat tax of 25% applied to different sources of foreign income. The Tax Relief Act provided no reductions in statutory tax rates but instead equally applied the 25% tax rate to every corporation. Therefore, the reduction in the statutory and ATR between 1998 and 2001 was smaller for corporations that had benefited from reduced taxation in the past. Some corporations even saw their tax rate rise: Operators of merchant ships in international waters were liable for a reduced rate of 22.5% in 1998, but in 2001, they used the universal tax rate of 25%.

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

with 1998. Fifth, corporations that used a fiscal year different from the calendar year switched to the half-income method and lower tax rate in 2002; in 2001, they were still taxed under the tax credit method and had to pay a tax rate of 40%. In turn, the reduction in the ATR for these corporations was much smaller than that for corporations taxed according to the half-income method as of 2001.[11]

In addition to the changes caused by the Tax Relief Act, a cap on the use of tax loss carry-forward (so-called minimum taxation) modified loss-offsetting rules in 2004. The minimum taxation and great variety in the availability of tax losses carried forward provide additional variation in the ATR that firms face.

3.4.3 Instrumental variable estimation

Because a company's ATR as well as its wage rate is influenced by managerial decisions and behavioral responses to the tax code, it is likely endogenous. Furthermore, contemporaneous macroeconomic shocks may produce correlation between wage rates and net profit before loss carry over (NPBL), a measure used to calculate the ATR. For these reasons, we apply an IV approach. Following the method proposed by Gruber and Saez (2002), we instrument a corporation's observed ATR for 2001 (2004) with the simulated ATR that the corporation would have faced in 2001 (2004) if its real tax base, including workforce and wages paid, had not changed endogenously between 1998 and 2001 (2004). Thus, we only use changes in the tax law and macroeconomic effects that are exogenous to the individual corporation to identify the CIT incidence. To simulate tax liabilities and counterfactual ATRs, we use the business taxation microsimulation model BizTax (see Section 3.8.2). The method first ages all income-related components of the 1998 cross-section to 2001 (2004) values using a nominal growth rate that is exogenous to the individual corporation (Section 3.8.2). Based on the inflated income components and BizTax, we then simulate the corporate tax liability according to the CIT law 2001 (2004). The simulated ATR for 2001 (2004) is a result of relating the simulated tax liability for 2001 (2004) to the inflated NPBL of 1998.

In the estimation, we control for other factors that might correlate with both labor market outcomes and ATR. First, we allow for group fixed effects and estimate the

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

regression equations on differenced data. Second, to control for time-varying factors influencing labor market outcomes, we include age and age squared, as well as indicators for women, full-time employed, and foreigners as control variables in the wage regressions.

Using a pseudo-panel, which we describe in more detail in the next section, our basic estimating equation is given by:

$$ln(\text{gross hourly wage}_{g,t}) = \alpha + \beta * d_{g,t=o+1} * \text{ATR}_{g,t-1} + \beta_2 * d_{t=o+2} * \text{ATR}_{g,t-2} \quad (3.2)$$

$$+\beta_3 * d_{t=o+3} * \text{ATR}_{g,t-3} + \psi' x_{g,t} + \Sigma_{t=1}^{T-1} \tau' \text{year}_t + \eta_g + \text{u}_{g,t} \quad (3.3)$$

where α is a constant, β is the semi-elasticity of wages toward ATR that we estimate, ψ is a column vector of regression coefficients, and x_g is a column vector composed of the control variables in pseudo-panel group g in year t. We also include year fixed effects ($year_t$) which also cover the outside option of the workers. In case of disagreement between employer and workers, workers receive the level of utility of an unemployed person; unemployment benefits correspond to 60% of the monthly wage income of the last 12 months employed and are constant across industries.[12] Because we estimate the equation in first differences, lagged by three periods, the group fixed effect, η_g, is removed. This also purges the outside option of the employer, who gets zero profit if wage bargaining remains without mutual consent. Finally, $u_{g,t}$ is an error term for each group, which may or may not be serially correlated.

We take the difference with respect to the variable lagged three periods because tax data are available every three years (see Section 3.5.1). Data on corporate taxes are available for the years 1998, 2001, and 2004 and coincide with the major part of the tax law reforms. The dummy variable $d_{g,t=o+1}$ equals 1 if year t follows a year with tax data observed ($t = o+1$); analogously, $d_{g,t=o+2}$ ($d_{g,t=o+3}$) is equal to 1 in the two (three) years after the tax data are observed. Our specification therefore allows for a gradual effect on wage rates to take place while restricting each of the dynamic effects

[12]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 about people having children in one industry but not in another, this neglect should not bias our results.

to be of the same magnitude, assuming the same amount of time has elapsed after the tax observation. The specification also takes into account the missing tax information for years other than 1998, 2001, and 2004; for years without information on taxes, all three beta coefficients are implicitly restricted to 0. In our basic estimation equation, the ATR is assumed to have no contemporaneous effect on wage rates; as we explain in Section 4.4, the ATR is defined as CIT assessed over NPBL and therefore is based on end-of-year results. If firms react to their end-of-year result by changing wage rates, it should occur only after a one-year time lag. As a robustness check, we also perform an estimation in which we allow for a contemporaneous effect, and the results barely change (see 3.5.1).

3.5 Data

3.5.1 Corporate tax return data

The German CIT return data we use come from the German Federal Statistical Office, which publishes them every three years, starting in 1992 (Gräb, 2006).[13] The latest year available is 2004. We use tax variations of the years 1998, 2001, and 2004 to measure incidence. We excluded the year 1995 from the analysis because no tax reform pertaining to corporate taxation occurred between that year and 1998. We could not include 1992 data, because industry classifications changed between 1992 and 1998, and it was impossible to align the data set for 1992 by industry with the industry classifications used in 1998, 2001, and 2004. Furthermore, the labor data we use for measuring wage rates and employment are not available on a consistent basis before 1998.

The micro data on corporate tax returns represent all corporations subject to the German CIT, which means nearly 740,000 firms in 1998 and about 860,000 in 2004. The data are derived from all tax returns filed in a given year and provide information on more than 100 items that are relevant for calculating the CIT. Information on tax loss

[13] For reasons of data protection, individual data are anonymized. Researchers may access the data through the research centers of the Statistical Offices (www.forschungsdatenzentrum.de/en/index.asp). English-language data are available at http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/EN

carry-forwards and on the CIT assessed is also part of the data set. Furthermore, the data set contains firms' characteristics such as industry, region, and legal form.

To estimate the incidence of the CIT on wages, we need information about capital as the complementary production factor. Until 2001, the CIT return data record the amount of equity capital at the individual corporate level as the sum of retained earnings since 1977 and contributions to capital as far as they occurred after the company was founded. To derive the values for 2004, we extrapolate the information using growth rates by industry.[14] Information on (long-term) debt is not available in the CIT statistics but can be derived from the local business tax statistics, because half of the interest payments on long-term debt[15] were liable to the local business tax. Local business tax statistics cover the same population of corporations and are available for the same years as the CIT statistics but could not be matched at the micro level until 2004.[16] Therefore, we impute interest payments at the level of aggregation we define in Section 3.5.3.[17] In the imputation, we further differentiate by profit deciles to take into account differences in firm size. For 2004, CIT and local business tax statistics could be matched at the firm level. As a sensitivity check of our imputation method, we used the integrated data set to compare our imputed interest payments with the factual ones. On our aggregation level, we did not see any noteworthy difference in the mean of imputed and factual values (see Appendix 3.8.3). Total capital is the sum of debt, equity, and the legal minimum deposit, which amounts to €25,000 for private limited liability companies and to €50,000 for public companies.[18]

[14]The German Central Bank (in special statistical publication 6: ratios from financial statements of German enterprises) provides information on financial statements of German companies by industry and year.

[15]In our observation period the definition of long-term debt was quite broad, including debt not paid back within 12 months and that taken out to improve business operations or to expand. Since 2008, one-quarter of interest payments (on long- and short-term debt), leasing charges, and rents have been liable to the local business tax.

[16]Similar to the CIT statistics, local business tax statistics are constructed from all tax returns filed for local business taxation. These statistics also include unincorporated firms that we dropped from the data set.

[17]The average interest rates for firm credits as recorded by the German Central Bank (series SU0506 and SU0509) enable us to infer long-term debt.

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

To measure changes in output,[19] we complement our data set with yearly information on sales from the value added tax (VAT) statistics of the German Federal Statistical Office. Because exports are not liable to VAT in Germany, they are not included in our sales variable. The VAT statistic is the only data source available at a level of aggregation that matches the sales data in our pseudo-panel, so we cannot adjust the sales data for export shares. Yet if export shares do not change in the observation 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.

Tax return data offer several distinct advantages compared with accounting data used in prior literature. First, they provide broad coverage of the corporate sector. Second, they record the CIT actually assessed and contain components important for calculating the ATR, such as the actual and potential amount of loss carry-forward. However, we also note some disadvantages. In particular, for data protection reasons, tax return data cannot be matched with information on employment and wage rates at the level of the individual corporation. Furthermore, we can use only three cross-sections, and the data are not available as a panel. To link tax to labor data and track firms over time, we construct a pseudo-panel. Before explaining the construction of the pseudo-panel (Section 3.5.3), we introduce the labor data set used for our analysis.

3.5.2 Labor market data

The Federal Employment Agency collects data about employed persons from the Social Security cards of roughly 32 million employees, unemployment benefit recipients, and job seekers. The Social Security account of each person contains two reports that employers must make to the employment agency: First, they have to notify the agency when any new employee enters their workforce or leaves the establishment. Second, they report on all their current employees at the end of each calendar year. The research institute of the Federal Employment Agency (IAB) assembles these data for scientific use. For the research question at hand, the labor market information in the pseudo-

[19] We use sales as a proxy for output in alternative dynamic specifications of our wage equation below.

panel is based on the full sample of micro data from the IAB's historical files of Social Security records from 1998 to 2006.

Several details of the data construction merit attention (for details, see Appendix D); on the 15th of each month in each year, wage observations were drawn from the historical files and weighted according to the length of employment (Section 3.8.4).[20] Unfortunately the data collected in the Social Security system do not include hours worked. We address this problem by matching data on normal working hours from the Microcensus[21] (Section 3.8.4), differentiated for 300 subgroups with regard to industry, gender, region, employment type (full-time, part-time, marginal), and education (low, medium, high). Data on marginally employed people appear in the Social Security system only from the second quarter of 1999 onwards. We use the development of employment and wage rates of the marginally employed between the first quarter and the remainder of the year through 2000 to extrapolate the number of marginally employed people and their wage rates for the first quarter of 1999 (Section 3.8.4). In the upper part of the wage rate distribution, observations are censored at the Social Security assessment ceiling, which for unemployment and old age insurance was €51,538 (€42,949) in 1998 and €63,000 (€52,800) in 2006 for West (East) Germany. We use median hourly wage rates to circumvent the problems associated with censored wage rate observations (see Section 3.5.4).

3.5.3 Constructing a pseudo-panel

To construct the pseudo-panel data set based on cross-sectional tax return and labor information, we grouped corporations and labor market observations by industry and region; for corporations with several establishments, the region was assigned according to the geographic location of the headquarters. The lowest regional level refers to the 16 German federal states. A corporation's industry and headquarter should remain unchanged over our short time horizon, and the location decision should not be influ-

[20]The IAB calculated daily pay on the basis of calendar days (365 days) instead of working days (255 days). We therefore re-weighted IAB daily pay (by multiplying with 365 days / 255 days = 1.43137) to obtain an employee's payment per working day.

[21]The Microcensus (which includes the official labor force survey, Arbeitskräfteerhebung) provides official representative statistics of the population and the labor market in Germany, including hours worked (see Section 3.8.4). Detailed information about the Microcensus is available from http://www.gesis.org/en/services/data/officialmicrodata/ microcensus/.

enced by tax reforms. Grouping by industry is natural, because some of the variation in taxation rules takes place at the industry level.

We aggregated the micro-level data into groups by applying a sequential procedure (see 3.8.5): First, we assessed the number of corporations and employees within each industry at the two-digit level. If there were more than 50 corporations and 20 employees at this level, we checked whether the industry could be disaggregated to the three-digit level, with the requirement that there were at least 50 corporations and 20 employees in the resulting group. If not, we kept the group at the two-digit level. Following this procedure, we proceeded to the five-digit level; some groups were quite large even at the five-digit level and included several thousand corporations and employees. For these groups, we used regional affiliation as a subordinate classification criterion and further differentiated the groups between eastern and western Germany and, if possible, among federal states. With this procedure, we assigned each corporation to one of 860 groups. The same classification of groups was applied to all cross-sections of tax return and labor data.[22]

We imposed a minimum group size of 50 corporations and 20 employees to reduce the measurement error in both dependent and explanatory variables due to changes in group composition over time related to the entry and exit of firms. This potential measurement error should become insignificant, on average, with a large number of observations per group, and time fixed effects can be eliminated by differencing all variables in our pseudo-panel.

3.5.4 Descriptive evidence on wage rates, employment, and the ATR

For each group constructed, we obtain the number of employed people, the wage rate, and a set of explanatory variables (see Section 3.8.4). The average number of employed people for each year is the sum of monthly employment divided by 12. As the wage rate,

[22]To address the slight change 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 draw the median wage rate from the yearly distribution of wage rates that again is weighted by monthly employment and employment spells. Thus we avoid the problem of censored observations in the right-hand tail of the distribution. The 50th percentile of wage rates is always below the Social Security assessment ceiling for the constructed groups. For the age variables, establishment size, work experience, and fractions of women, foreigners, and full-time employees, we computed average values, weighted by the number of employees in a given month and year.

Table 3.1: Descriptive statistics of labor data

	1999	2000	2001	2002	2003	2004	2005	2006
Hourly wage rate in euros (median)	11.49	11.41	11.69	11.97	12.19	12.02	11.94	11.97
	3.55	*3.67*	*3.8*	*3.92*	*4.07*	*4.15*	*4.27*	*4.38*
Employment (number of employees)	34,896	37,200	37,289	36,540	36,029	36,805	36,257	36,736
	97,171	*101,128*	*100,986*	*100,220*	*98,890*	*99,922*	*97,382*	*98,166*
Age (average)	38.89	39.21	39.43	39.76	40	40.27	40.57	40.72
	2.6	*2.69*	*2.73*	*2.72*	*2.69*	*2.66*	*2.65*	*2.58*
Share of women (average)	0.41	0.42	0.41	0.41	0.41	0.42	0.41	0.41
	0.21	*0.21*	*0.21*	*0.21*	*0.21*	*0.2*	*0.2*	*0.2*
Share of foreigners (average)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	0.06	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
Share of full-time employed (average)	0.76	0.75	0.75	0.75	0.74	0.73	0.72	0.72
	0.22	*0.19*	*0.19*	*0.18*	*0.19*	*0.17*	*0.17*	*0.17*
Number of groups	860	860	861	861	865	865	865	864

Notes: All information is at the aggregate level 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 3.8.4). The number of groups slightly varies across years as the panel is not balanced for eleven groups.
Source: Own calculations, based on Institute for Employment Research, aggregated data from the historical files, 1999 to 2006.

As noted in Section 3.5.1 the ATR is calculated at the individual corporate level for each year;[23] we then aggregated individual ATRs to the group level of the pseudo-panel structure described in the previous subsection, taking into account differences in group size.[24]

[23]To avoid problems with outliers, we dropped corporations with an exceptionally large or small ATR, exceeding 100% or 100%. In some groups, one corporation was much larger in terms of NPBL than the next largest corporation. We excluded corporations whose NPBL exceeded the second-largest NPBL by more than the factor 100 (1998 = 11 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.

[24]We estimate the incidence of the CIT by applying differences (see Section 3.4.3), such that we control for differences in firm size or other variables. Therefore, we do not need to use further weights but can calculate the group information within each group g as the unweighted average of the individual information from firm i. The average ATR in group g at time t is given by $ATR_{g,t} = \frac{1}{N_{g,t}} \Sigma_{N_{g,t}}^{i=1} ATR_{i,t}$.

In Table 3.1 and Table 3.2, we present the means and standard deviations of our labor market and tax variables, measured at the group level. All variables in nominal monetary terms (i.e., wage rates, sales, capital) are deflated using producer price indices of the corresponding industries from the German Federal Statistical Office. We use producer price indices for deflation to partial out any adjustment in prices that might result from a change in taxation. To account for measurement errors in imputed hours[25] in the hourly wage rate data, we exclude median wage rates below €3. Median wage rates for all employees amounted to about €11.49 per hour in 1999. After a compression in 2000, real wage rates have risen since 2001, before contracting again from 2004 on. Average employment across groups ranged between 35,000 and 37,000 from 1999 to 2006. The shares of women, foreigners, and full-time employees also showed a stable pattern in group averages across time.

As Table 3.2 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%. Compared with a drop of the statutory tax rate by 20 percentage points for most corporations (Sections 3.4.1 and 3.4.2), the reduction in ATR was much smaller. Various factors contributed to this difference, which we exploit to identify tax incidence (Section 3.4.2).[26]

The potential loss carry-forward nearly doubled, on average, between 1998 (€690,000) and 2004 (€1.2 million). The share of corporations with tax loss carry-forward at the beginning of 2004 amounts to 57.8% in 2004 and adds to the variation introduced by

[25] Measurement error might arise as the Microcensus contains few observations for some industry-labor market categories on which to base hour information.

[26] Compared with other measures of effective tax rates for our observation period and in Germany (e.g., Buijink et al. (1999); Nicodeme (2001, 2002); Gorter and de Mooij (2001); Devereux et al. (2003)), our average tax rates seem surprisingly low. ATRs also differ from those based on aggregate revenue data published by the OECD and the European Commission, 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. The profit measure used to calculate average corporate tax rates also differs from corporate taxable income or NPBL. The European Commission (2003) uses the net operating surplus of the business sector and includes unincorporated enterprises. 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, and our data set contains many firms (40%) that report a loss or zero profit, which significantly reduces the average ATR.

the changes to the CIT system. Economic activity, as measured by average sales in real terms, increased steadily from €284 million in 1998 to €374 million in 2006. Total capital increased from €4.4 million in 1998 to €6.7 million in 2006.

Table 3.2: Descriptive statistics of firm data

	1998	1999	2000	2001	2002	2003	2004	2005	2006
ATR (average)	0.115	-	-	0.075	-	-	0.077	-	-
	0.041	-	-	*0.025*	-	-	*0.025*	-	-
Potential tax loss carry-forward (average in euros)	686,723	-	-	798,393	-	-	1,225,920	-	-
	2,284,864	-	-	*3,839,518*	-	-	*7,102,556*	-	-
Share of corporations with tax loss carry-forward	0.547	-	-	0.559	-	-	0.578	-	-
at the beginning of the year (average)	*0.086*	-	-	*0.09*	-	-	*0.076*	-	-
Sales (average in 1,000 euros)	284,452	299,244	322,385	349,812	321,210	328,209	331,889	333,290	373,642
	690,148	*725,146*	*808,069*	*932,492*	*749,732*	*802,732*	*792,904*	*745,747*	*826,938*
Total capital (average in euros)	4,357,581	4,198,966	4,226,983	4,492,553	4,334,942	4,418,989	4,753,756	5,418,002	6,711,602
	27,755,155	*23,666,623*	*21,305,285*	*20,693,022*	*19,307,501*	*20,767,076*	*25,068,799*	*36,046,398*	*62,520,030*
Number of groups	862	860	860	861	861	865	865	865	864
Number of corporations within each group	855.635	-	-	934.64	-	-	992.508	-	-
	2,221.46	-	-	*2,598.20*	-	-	*3,106.63*	-	-
Number of corporations									
All corporations	736,603	-	-	812,527	-	-	857,466	-	-
Corporations with tax loss carry-forward	369,324	-	-	405,460	-	-	438,310	-	-
at the beginning of the year									

Notes: All information is at the aggregate level and in prices from 2000. Standard deviations of variables are in printed in italics just below. The number of groups slightly varies across years as the panel is not balanced for eleven groups.

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

3.6 Estimation Results

3.6.1 Tax incidence and wage bargaining without employment effects

In a standard OLS regression that does not account for group fixed effects, taxes have a positive effect on wage rates,[27] which is inconsistent with theoretical predictions. The positive relationship between the ATR and wage rates might arise because ATR captures unobserved profitability of the firm, i.e., more profitable firms face higher tax rates ceteris paribus and are able to pay higher wage rates. When we estimate the equation in first differences lagged three periods, coefficient estimates for the ATR change signs and become negative, with a long-run semi-elasticity of -0.555 (p = 0.205).

As explained in Section 3.4.3, exogeneity of changes in ATR with regard to a change in wage rates cannot be assumed. A standard Hausman test on endogeneity, in which we compare the OLS estimates with the 2SLS regression, indicates that ATR is endogenous in the wage regression; the c2 test statistic equals 25.06 (p = 0.001).[28] To obtain a consistent estimate of the actual elasticity of the wage rate with regard to the ATR, we employ two-stage least squares (2SLS) in all subsequent estimations of equation (2) and instrument the ATR with its simulated counterfactual. The 2SLS results are shown in Table 3.3. All specifications include time-fixed effects and were estimated with robust standard errors to correct for potential heteroscedasticity that may arise due to different group sizes or serial correlation in the error terms.

Column (1) reports 2SLS results without further control variables; column (2), shows the specification commonly used in the literature to assess incidence. It includes control variables, but does not pick up explicitly any employment-related variables. Control variables all show the expected signs. The first-stage results of the specification appear in Section 3.8.6. The simulated ATRs constitute suitable instruments, and the overall fit of the three regressions is 0.77 or higher. Calculations of the partial R^2 of excluded instruments, as proposed by Shea (1997) and Godfrey (1999), yield values between 0.293

[27] The long-run semi-elasticity of the wage rate with respect to the ATR of 9.177 is statistically insignificant (p = 0.522).

[28] We also carried out the test based on robust standard errors as proposed by Cameron and Trivedi (2009, p.429). The χ_2 test statistic equals 23.15 (p < 0.001) and rejects exogeneity of the ATR just as much.

and 0.494, which clearly confirms the relevance of our instruments and indicates that our 2SLS estimation strategy is not subject to the well-known weak instrument problem. Simulated ATRs in all further specifications are highly correlated with the actual ATRs, much like the results in column (2).[29]

According to column (2), which closely follows the usual specification in previous literature, the long-run semi-elasticity of the wage rate with respect to the ATR is -1.643; its magnitude is similar to estimates found in previous literature as summarized in Section 3.2. This implies a one percentage point decrease in the ATR increases wage rates by about 1.6%. The effect is not statistically different from -1 at the 5% level (two-sided test, $\chi_2 = 4.35$).

To check whether this estimated long-run elasticity of the wage rate is sensitive to our assumption that changes in the ATR affect wage rates with a one-year time lag, we allow for a contemporaneous effect of the ATR on wage rates in the dynamic specification of our estimation equation. This alternative specification yields a semi-elasticity of -1.656 (column (3)), which is not statistically different from the results in column (2) at any conventional significance level.

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 staggered wage adjustment in consequence of multi-year bargaining agreements which are quite common, especially in the manufacturing sector of the German economy. To estimate the long-run semi-elasticity of the wage rate with respect to the ATR, allowing for a more general dynamic form of dynamic adjustment, we add the lagged dependent variable to the specification in column (2) (columns (4) and (5)). Column (4) reports regression results if lagged wage rates are assumed to be exogenous; in column (5), we instrument lagged wage rates by the fraction of low-skilled workers lagged by four periods. Adding the lagged dependent variable, which gives more time for firms to adjust to the tax reform, slightly reduces the point estimate of the estimated semi-elasticity (to -1.321) but substantially increases its estimated standard error, even though the semi-elasticity is still significant at the 5% level (χ_2-value = 4.209).

Columns (6) and (7) show that the point estimates of the semi-elasticity of the wage rate with respect to the ATR change little when we add sales as further control variable.

[29] First-stage results for all further specifications are available from the authors upon request.

Sales have a positive and statistically significant effect on the wage rate: A 1% increase in sales raises the wage rate by approximately 0.2% (column (6)). As mentioned previously (Section 3.5.1), our sales variable does not include exports. If export shares remain unchanged in the observation period, this measurement error should be accounted for by the group fixed effects, such that they get purged from the differenced regression. This is also true for shocks to the wage rate, which may affect the volume of sales as long as this relation has remained stable during the observation period. Both these assumptions clearly could be questioned, so we instrument the potentially endogenous sales variable using the fourth lag of sales. In column (7), this approach significantly increases the elasticity between the wage rate and sales from 0.019 to 0.059, but it only slightly affects the size and significance of our point estimate for the wage rate semi-elasticity with respect to the ATR.

As a sensitivity check we include capital as an additional regressor (columns (8) and (9)), assuming that the capital stock can be treated as quasi-fixed in the medium-run. The coefficient of capital is statistically significant but pretty small, and including capital hardly affects the estimated wage rate semi-elasticity with respect to the ATR. We therefore conclude that there is a negligible effect of a change in capital on the wage rate.

Table 3.3: Semi-elasticity of the hourly wage rate with respect to taxes (2SLS estimation)

Dependent variable:	2SLS										
log(gross hourly wage rate$_{g,t}$)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
ATR$_{g,t}$	-	-	-0.688	-	-	-	-	-	-	-	-
			(0.246)								
ATR$_{g,t-1}$	-0.63	-0.547	-0.5	-0.297	-0.207	-0.518	-0.43	-0.501	-0.478	-0.699	-0.576
	(0.189)	(0.192)	(0.195)	(0.171)	(0.192)	(0.200)	(0.225)	(0.193)	(0.200)	(0.255)	(0.261)
ATR$_{g,t-2}$	-0.514	-0.499	-0.468	-0.242	-0.15	-0.451	-0.323	-0.461	-0.418	-0.755	-0.597
	(0.184)	(0.188)	(0.185)	(0.144)	(0.148)	(0.188)	(0.203)	(0.187)	(0.187)	(0.235)	(0.226)
ATR$_{g,t-3}$	-0.508	-0.596	-	-0.297	-0.191	-0.571	-0.487	-0.56	-0.538	-0.912	-0.786
	(0.153)	(0.144)		(0.116	(0.140)	(0.145)	(0.154)	(0.143)	(0.145)	(0.178)	(0.168)
log(gross hourly wage rate$_{g,t-1}$)	-	-	-	0.431	0.585	-	-	-	-	-	-
				(0.047)	(0.094)						
log(employment$_{g,t}$)	-	-	-	-	-	-	-	-	-	-0.204	-0.184
										(0.044)	(0.041)
Age$_{g,t}$	-	0.18	0.266	0.087	0.054	0.185	0.187	0.181	0.186	0.183	0.19
		(0.036)	(0.033)	(0.039)	(0.040)	(0.036)	(0.036)	(0.037)	(0.036)	(0.037)	(0.036)
Age squared$_{g,t}$	-	-0.002	-0.003	-0.001	0	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Share of women$_{g,t}$	-	-0.602	-0.642	-0.415	-0.348	-0.578	-0.528	-0.59	-0.569	-0.814	-0.744
		(0.098)	(0.085)	(0.092)	(0.101)	(0.097)	(0.097)	(0.099)	(0.098)	(0.117)	(0.109)
Share of foreigners$_{g,t}$	-	-0.155	-0.262	-0.08	-0.052	-0.142	-0.117	-0.156	-0.144	0.074	0.072
		(0.065	(0.069	-0.05	-0.05	(0.063	(0.062	(0.065	(0.063	(0.095	(0.089
Share of full-time employed$_{g,t}$	-	0.04	0.069	0.025	0.02	0.037	0.03	0.041	0.038	0.078	0.071
		(0.009	(0.010)	(0.008)	(0.008)	(0.009)	(0.010)	(0.009)	(0.009)	(0.022)	(0.019)
Log(sales$_{g,t}$)	-	-	-	-	-	0.019	0.059	-	0.014	-	0.032
						(0.003)	(0.015)		(0.003)		(0.006)
Log(capital$_{g,t}$)	-	-	-	-	-	-	-	0.016	0.018	-	0.017
								(0.003)	(0.003)		(0.004)
Constant	-0.013	-0.03	-0.021	-0.028	-0.027	-0.033	-0.041	-0.029	-0.032	-0.012	-0.019
	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.005)	(0.004)	(0.004)	(0.006)	(0.005)
Long-run semi-elasticity with respect to ATR	-1.653	-1.643	-1.656	-1.47	-1.321	-1.54	-1.239	-1.521	-1.433	-2.366	-1.96
	(0.305)	(0.308)	(0.365)	(0.444)	(0.644)	(0.285)	(0.333)	(0.311)	(0.315)	(0.404)	(0.394)
Long-run elasticity with respect to ATR	-0.19	-0.189	-0.19	-0.169	-0.152	-0.177	-0.142	-0.175	-0.165	-0.272	-0.225
at average ATR of 1998	(0.035)	(0.035)	(0.042)	(0.051)	(0.074)	(0.036)	(0.038)	(0.036)	(0.036)	(0.046)	(0.045)
Number of observations	4,283	4,283	5,143	4,283	4,283	4,237	4,237	4,282	4,236	4,238	4,236

Notes: Heteroskedasticity-consistent robust (Huber-White) standard errors are reported in parentheses. All estimates are based on first-differenced data lagged three periods and include time fixed effects. In all estimations the ATR is instrumented by the simulated ATR (see text); in columns (5) and (7), we additionally instrument the lagged wage rates by the fraction of low-skilled workers lagged by four periods and sales by its fourth lag. Employment is instrumented by the fourth lag of the fraction of low-skilled workers.

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

All long-run semi-elasticities in columns (3) through (9) are very similar in value to the results in column (2), which underpins the stability of the estimate. How would the results in column (2), which is comparable to results in previous literature, relate to the incidence of the CIT, as measured by its effect on the total wage bill? The average ATR across groups was 11.49% in 1998, and the aggregate CIT assessed was € 36.28 billion in the same year. A cut of the ATR by one percent would thus decrease aggregate CIT revenues by € 0.42 billion. The total gross wage bill of corporate enterprises was € 350.17 billion.[30] Assuming no adjustment in total employment occurs in response to a newly bargained wage and using the elasticity estimate from our specification in column (2), which amounts to -0.189, this change in ATR would trigger an increase in the wage bill by € 0.66 billion. In response to a € 1 decrease of corporate tax revenues labor would thus benefit from a € 1.56 wage increase.[31]

The higher average pay, however, makes labor more costly and might lead the firm to lay off some employees. Leaving employment out of the wage equation thus potentially entails an omitted variable bias. We therefore suggest to include employment as a regressor (while taking its endogeneity into account) in the wage equation to estimate the elasticity of the wage rate with respect to the ATR holding employment fixed in the first step; in the second step we estimate the wage rate elasticity of employment to account for the mediated, countervailing effect of firms adapting employment, as induced by the change in wages on the total wage bill, in our incidence calculations.

3.6.2 Tax incidence including employment effects

Column (10) in Table 2 shows the estimation results when we additionally include the natural log of employment into our regression from column (2). As explained previously, we measure employment by a head count of employees in each group. Apart

[30] The National Income and Expenditure Survey puts total compensation of employees, less those employed by the state, private households, and the rest of the world, at € 720.09 billion in 1998. We adjust total compensation by a factor of 0.80 (total gross wages/total compensation in 1998) to attain total gross wages. We scale the remainder by a factor of 0.55 (fraction of sales generated by firms subject to the CIT, according to value-added tax statistics in 1998, and fraction of employees employed by corporations according to the German Business Register 2007) to gauge the fraction of compensation paid in companies subject to the CIT. Because corporations are larger, on average, we assume that wages paid are 10% above average wages; this leads us to a total wage bill of (1+0.1)*318.33 billion euros in 1998.

[31] This wage increase is statistically not different from € 1 at the 5% significance level. The 5% confidence interval is [0.97;2.14].

from the instruments used before we use the fourth lag of the fraction of low-skilled workers as an additional instrument. While there is no way to test the exclusion restriction we consider the fraction of low-skilled employees in the period before the latest lag of the differenced tax variable as far enough removed from the differenced wage variable and hence the error term in question. The specification with employment as an additional regressor leads, in absolute terms, to a higher estimate for the semi-elasticity of the wage rate with respect to the ATR: Keeping the number of employees constant, the long-run semi-elasticity is about one-third larger in absolute value and amounts to -2.366. As in the regressions without employment, estimates of the ATR are significant on any conventional statistical level (χ_2-value = 34.23).

To test for the sensitivity of this result, we subject our estimate to various robustness checks. Column (11) shows that including capital and output only slightly decreases the absolute value of the estimated semi-elasticity of the wage rate with respect to the ATR. Confidence intervals of the long-run semi-elasticity largely overlap in both specifications. Including capital and output separately leaves estimates virtually unchanged.[32] calculations we therefore use column (10) as our preferred specification.

To derive the CIT incidence we also need to know by how much employers change their workforce in response to a change in the wage rate. To this end we estimate an employment equation (equation (3)) as described in Section 3.4.3. The data is first-differenced to eliminate group specific effects. A dummy for East Germany and an interaction term with the year dummies are also included to capture differential employment trends in East and West Germany. We again used robust standard errors to correct for potential heteroscedasticity that may arise due to different group sizes or serial correlation in the error terms. The 2SLS estimation results are shown in Table 3.4. As instruments for the most likely endogenous contemporaneous wage rate and UCC variables we use the simulated counterparts of the UCC, the fourth lag of the real wage, and first differences of the third lag in shares of education. The Sargan test and the partial R^2 Shea indicate that our instrumental variables are valid and relevant.

The estimation results (Table 3.4) suggest a wage rate elasticity of employment of -1.06. We cannot reject the null hypothesis that the wage rate elasticity of employment

[32]Detailed estimation results are available from the authors upon request.

Table 3.4: Elasticity of employment (2SLS estimation)

Dependent variable: $\log(\text{employment}_{g,t})$	2SLS	
$\text{UCC}_{g,t-1}$	-0.862	-0.909
	(0.579)	(0.579)
$\text{UCC}_{g,t-2}$	-1.378	-1.364
	(0.570)	(0.570)
$\text{UCC}_{g,t-3}$	-1.714	-1.719
	(0.478)	(0.478)
$\log(\text{gross hourly wage rate}_{g,t})$	-1.066	-0.997
	(0.100)	(0.010)
$\text{Age}_{g,t}$	0.246	0.238
	(0.048)	(0.048)
$\text{Age squared}_{g,t}$	-0.003	-0.003
	(0.001)	(0.001)
$\text{Share of women}_{g,t}$	-1.708	-1.822
	(0.177)	(0.177)
$\text{Share of foreigners}_{g,t}$	0.983	1.018
	(0.159)	(0.159)
$\text{Share of full-time employed}_{g,t}$	0.223	
	(0.027)	
Time fixed effects	yes	yes
Dummy for East Germany	yes	yes
Time dummies dummy for East Germany	yes	yes
Long-run semi-elasticity with respect to UCC	-3.954	-3.991
	(0.941)	(0.942)
Long-run elasticity with respect to UCC at average UCC of 1998	-0.436	-0.440
	(0.104)	(0.104)
Number of observations	4,290	4,283
Sargan test statistic	3.518	4.911
... p-value in χ^2-distribution	0.318	0.178
R^2Shea:		
... $\text{UCC}_{g,t-1}$	0.280	0.280
... $\text{UCC}_{g,t-2}$	0.287	0.286
... $\text{UCC}_{g,t-3}$	0.488	0.488
... $\log(\text{gross hourly wage}_{g,t})$	0.251	0.255

Notes: Heteroskedasticity-consistent robust (Huber-White) standard errors are reported in parentheses. Estimates are based on first-differenced data lagged three periods. In all estimations the UCC is instrumented by the UCC constructed with the simulated ATR (see text).
Source: Own calculations based on Institute for Employment Research, aggregated data from the historical files, 1999 to 2006, German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998, 2001, and 2004, local business tax statistics 1998, 2001, and 2004, value added tax statistics 1998 to 2006.

is equal to -1 at any conventional level of significance. An increase in the wage rate by 1 percent thus leads to a reduction in employment by 1 percent.

How does the elasticity of employment affect tax incidence results? To determine tax incidence that includes employment effects, we calculate the tax elasticity of the wage bill, $\eta_{\text{wage bill, ATR}}$, as

$$\eta_{\text{wage bill, ATR}} = \left[1 + \eta_{\text{employment, wage rate}}\right] \times \eta_{\text{wage rate, ATR}} + \eta_{\text{employment, UCC}} \times \eta_{\times UCC,ATR}. \tag{3.4}$$

Turning to our estimation results from Tables 3.3 (column (10)) and 3.4, we find $\eta_{\text{wage rate, ATR}} = -0.272$, $\eta_{\text{employment, wage rate}} = -1$, and $\eta_{\text{employment, UCC}} = -0.436$. Because we approximate the UCC by the tax rate normalized by output prices, the elasticity of the UCC with respect to the ATR, $\eta_{UCC,ATR}$, is equal to ATR/(1-ATR)=0.130.[33] Combining elasticities yields a tax elasticity of the wage bill of -0.057.[34]

As mentioned above, a one percent cut in the ATR decreases CIT revenues by €0.42 billion. Based on a long-run elasticity of the wage bill with respect to the ATR of -0.057, the decline in taxes gives rise to an increase in the wage bill by €0.20 billion. Setting this change against the decrease in CIT revenue of €0.42 billion, yields the total tax incidence accounting for employment effects. We thus find that a €1 decrease of corporate tax revenues results in a €0.47 increase of the wage bill, implying that labor overall benefits from about half the amount of CIT reduction.[35]

The overall effect of corporate taxes on the wage bill as the sum of the wage bargaining and the user cost of capital effect is clearly different from the size of effects found when following the conventional approach, in particular regarding the employment implications of changes in the CIT. Our empirical results for the wage bargaining effect confirm that a wage change is set off completely by the subsequent employment adjustments. While wage rates do react to changes in the tax rate, the effect on the wage

[33] The derivation of the UCC in logs with respect to the log of the ATR is given by -(-ATR)/(1-ATR), with ATR equal to 0.1149 in 1998.

[34] $[1 + (-1)] \times (-0.272) + (-0.436) \times 0.130 = -0.057$.

[35] Because of the relatively large standard error of the elasticity of employment with respect to the UCC, we also calculate the incidence at the lower and the upper limit of the 5% confidence interval of the employment elasticity with respect to the UCC. The implied confidence interval of the incidence estimate is pretty large and lies between 0.24 and 0.69.

bill clearly cannot be determined without considering the corresponding employment effects. The results furthermore show that neglecting the user cost of capital effect only tells half the truth as a change in the UCC, mediated through adjustments in employment, also alters the wage bill.

3.7 Conclusion

The aim of this study has been to assess how much of the burden on capital is borne by labor. Literature has identified two pathways through which taxes on corporate income are passed onto workers by lowering their wage rates. First, taxes on capital are shifted by reducing capital investment and second, through wage rate bargain over economic rents. The "wage bargaining effect" arises because the corporate income tax (CIT) reduces the profit workers and firm owners can bargain over. In our analysis we focused on the wage bargaining channel but also integrated employment and thus wage bill effects that arise from changes in the user cost of capital (UCC) due to changes in CIT ("user cost of capital effect").

Previous empirical studies suggested that labor bore the full or even more than the full CIT burden. These incidence estimates have been criticized as too large to be consistent with theoretical considerations. We argue that the implausibly large share borne by labor might reflect the fact, that most studies in the field estimate only part of the overall effect of corporate taxes on wage bill. Yet, the exclusive focus on the relationship between tax rates and wage rates found in some studies neglects the countervailing effect of adjustments in labor demand and finally the wage bill. In this study, we have focused on a right-to-manage setting where wage rates are negotiated over, with the employer retaining the right to adjust the workforce once the wage rate is set. We assessed the overall effect of CIT on the wage bill, including the effect on wages mediated through subsequent employment effects. To estimate this mediated effect, we calculated how employment is affected by a change in the wage rate and the UCC, as induced by the tax change.

In our estimations we rely on a unique pseudo-panel data set that combines tax return data on the universe of corporations subject to German CIT and labor market variables based on the full record of employees on Social Security payroll in Germany.

An important advantage of the tax return data we use is that they enable us to calculate firm-specific average tax rates (ATR) while taking into account various other tax shields, including loss carry-forward, which has major quantitative importance for the corporate sector. In our observation period from 1998 to 2006, companies were affected unequally by various changes in CIT regulation between 1999 and 2004, such as the decrease in the statutory tax rate and the broadening of the tax base. We use this variation in the ATR in a dynamic estimation framework to gauge the long-run effects of corporate taxation on wage rates. The estimation in differences purges the group-level fixed effects, and we overcome endogeneity of the actual ATR by applying an instrumental variable approach. As our instrument of observed ATR, we use a counterfactual ATR that a corporation would have faced in a particular period, had it not responded to the reform within that period. This counterfactual tax rate is constructed on the firm level using a detailed microsimulation model of the corporate sector. More precisely, we update firms' pre-reform tax return information to post-reform years using exogenous inflation parameters. The hypothetical tax information we thus obtain is then subjected to the actual tax regulations of the post-reform year considered.

Our preferred estimation yields a semi-elasticity of the wage rate with respect to a one percentage point change in the ATR of about -2.37. Correcting for employment effects with the wage rate elasticity of employment estimated to equal the neoclassical benchmark of -1, we find that, on the aggregate, labor cannot benefit from a cut in corporate income tax rates through wage bargaining. Any increase in the total wage bill by higher wage rates set is equally compensated for by lower levels of employment, as long as the effect of the tax change on the UCC and hence adjustments of the capital stock on employment are not considered. If we additionally take account of the latter effect, a € 1 decrease of corporate tax revenues results in an increase of the wage bill by € 0.47.

Previous studies have assumed employment not to react to changes in the wage rate and have found that labor bears the full burden, or even more, of the tax. We show that not accounting for further adjustments of employment gives an incomplete account of the wage bargaining effect of corporate taxes on the wage bill in a labor market marked by collective bargaining and exaggerates the CIT share shifted onto labor.

3.8 Appendix

3.8.1 Components of the corporate income tax assessed

Turnover − Deductions such as interest payments and depreciation allowances
− Wage payments
+/− (...)
Profit as shown in tax balance sheet[36]
+/− Correcting entry concerning valuation (e.g., adjustment of values of balance sheet items, non-tax-deductible losses, non- tax-relevant gains)
+ Correction of activities related to shareholders (e.g., declared profit distributions and constructive dividends, repayment of capital or capital increase, hidden contribution, other deposits under company law)
+ Non-deductible operating expenses (e.g., taxes paid, 50% of payment to members of the supervisory board)
+/− Non-tax-relevant domestic increases/ decreases in net worth (e.g., inter-company dividends, investment subsidies)
+/− Corrections related to double taxation agreements, tax legislation relating to non-residents, and fiscal units
= ***Net profit before consolidation and loss carry over***
− Allowable deductions for agriculture and forestry
− Deductible donations and contributions
+/− Income generated by controlled entities
= ***Net profit before loss carry over (NPBL)***
− Loss carry-forward and loss carry-back
= ***Net Income***
− Allowable deductions for commercial cooperatives
= ***Taxable Income***

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

$*$ Statutory tax rate
$-$ Tax credits for foreign-source income
$=$ ***Corporate income tax assessed***

3.8.2 The BizTax model and details on the construction of the simulated ATRs

The BizTax model

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

Because our microsimulation tax model does not include a switching rule between loss and profit, we assume a corporation that reports a profit in 1998 does so in 2001 (2004) as well. This assumption is inoffensive, because it merely affects the efficiency of our instrument.

Aging of income-related components

Thirteen inflation parameters pertain to different sources of income (e.g., profits and losses, dividends and income from interest, financial and non-financial corporations). The computation of these parameters ensured that inflated profits and interest reflected changes in the corresponding aggregates in the national accounts and the German Central Bank corporate balance sheet statistics. We assume that income growth factors do not depend on the level of corporate income in 1998, conditional on group fixed effects (see Gruber and Saez (2002)).

We note the concern that this simulated ATR is not completely exogenous for corporations that offset part (or all) of their profits in 1998 against unused loss carry-forward

from the past or 1999 (loss carry-back), because the amount of profits that can be offset against losses from other periods is a function of the tax rules. Because the Tax Relief Act broadened the tax base and increased NPBL, it produced a rise in the ATR and the need for a larger volume of losses from other periods to offset the higher NPBL. Even if the tax losses carried forward (back) were sufficient in volume to (mainly) offset profits before the reform, they might no longer be after the broadening of the tax base. In turn, the ATR would increase for corporations without sufficient losses and stay unchanged for those with abundant losses. Because the ability to offset the higher NPBL that resulted from the tax reform might relate to unobserved factors, which also could influence wages paid or the number of employees, we acknowledge that tax loss carry-forward or carry-back could be endogenous. To address this potential endogeneity, we inflate the amount of profits offset against losses from other periods in 1998 and use this amount as an upper limit in our simulation of a corporation's ATR for 2001 (2004). In a similar vein, we use the inflated amount of allowable deductions effectively used in 1998 when we simulate the corporation's ATR for 2001 (2004).

3.8.3 Imputed and firm-specific debt

Table 3.5: Imputed and firm-specific debt

	Debt Derived from	
Percentiles	Imputation	Firm-specific information
1%	124	142
5%	1,740	1,746
10%	2,665	2,688
25%	4,355	4,360
50%	10,780	10,770
75%	23,797	23,797
90%	56,168	56,168
95%	97,958	97,962
99%	776,590	776,590
Mean	58,939	58,946
Standard deviation	505,374	505,374

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

3.8.4 Details on the data sources and variables used for estimation

Calculation of group-level variables based on labor market data

Wage observations are drawn 12 times on the 15th of each month for each year. The monthly gross wage is broken down according to the length of the spell on a daily level. This procedure ensures that we do not oversample observations with longer employment spells and account for shorter employment spells (i.e., due to seasonal employment). To convert daily wages into hourly wages, we use the (imputed) working hours information from the Microcensus, matched to the individual wage information.

Our dependent variable is the median of the hourly wage, with the wage distribution including all observations drawn. Therefore, hourly wages for an individual who was employed during the full year enter the hourly wage distribution 12 times, whereas a person employed only on the 15th of a single month appears just once. Wage percentiles were then drawn from the entire distribution of hourly wages in each year.

Control variables are measured as average values and fractions. For simplicity, we leave the year subscripts out of the following formulas. For group g in a specific year, the average number of employed individuals $\bar{N}_g$ is

$$\bar{N}_g = \frac{\Sigma_{m=1}^{12}\Sigma_{i=1}^{N_{g,m}} n_{i,g,m}}{12} \tag{3.5}$$

where i refers to the individual; m to the 12 months of the year, $m = 1,,12$; and $N_{g,m}$ to the total number of observations in group g in month m, $N_{g,m} = \Sigma_{i=1}^{N} n_{i,g,m}$ with $n_{i,g,m} = 1$.

Average values for age, age squared, establishment size, work experience, and hourly wages are computed using the number of individuals in each month as weights to account for seasonal effects:

$$\overline{age_g} = \frac{\Sigma_{m=1}^{12}\left(\frac{\Sigma_{i=1}^{N_{g,m}} \text{age}_{i,g,m}}{\Sigma_{i=1}^{n_{i,g,m}}} * N_{gm}\right)}{\Sigma_{m=1}^{12} N_{g,m}} \tag{3.6}$$

$$= \frac{\Sigma_{m=1}^{12}\Sigma_{i=1}^{N_{g,m}} \text{age}_{i,g,m}}{\Sigma_{m=1}^{12} N_{gm}}. \tag{3.7}$$

The fraction of women was calculated using

$$\overline{\text{fraction female}_g} = \frac{\Sigma_{m=1}^{12}\left(\overline{\text{fraction female}_{gm}} * N_{gm}\right)}{\Sigma_{m=1}^{12} N_{g,m}}. \tag{3.8}$$

The fractions of foreigners and people in full-time employment were calculated analogously.

Hours information from the Microcensus

The Microcensus is a representative survey of a random 1% sample of German households. Among other things, it provides information on whether respondents are employed and how many hours per week they normally work, as well as the industry in which they are employed, region or residence (federal state), type of employment (full-time, part-time, marginal employment), gender, schooling (highest degree completed in terms of secondary education), and highest educational degree completed (i.e., vocational training, university degree). We use this information to obtain average working hours for certain subgroups while ensuring sufficient cell sizes in the aggregation. Therefore we group individuals for the years 1999-2006 across 25 industries. Within each industry, we generate 12 labor market categories that differentiate the following categories: East/West Germany, male/female, full-time/part-time/marginal employment, and low/medium/high qualification. We then determine normal hours worked for each of these year-industry-labor market categories.

Imputation of the number of marginally employed people in Q1/1999

The number of marginally employed people in group g in month k in the first quarter of 1999, $ME_{g,k}^{1999}$, g,k ME , was computed using the following formula, where month $k = 1,2,3$ refers to months January, February, and March, respectively, and $l = 4,...,12$ indicates April through December:

$$ME_{g,k}^{1999} = \left(\frac{ME_{g,k}^{2000}}{\Sigma_{l=4}^{12} ME_{g,l}^{2000}}\right) * \Sigma_{l=4}^{12} ME_{g,l}^{1999}. \tag{3.9}$$

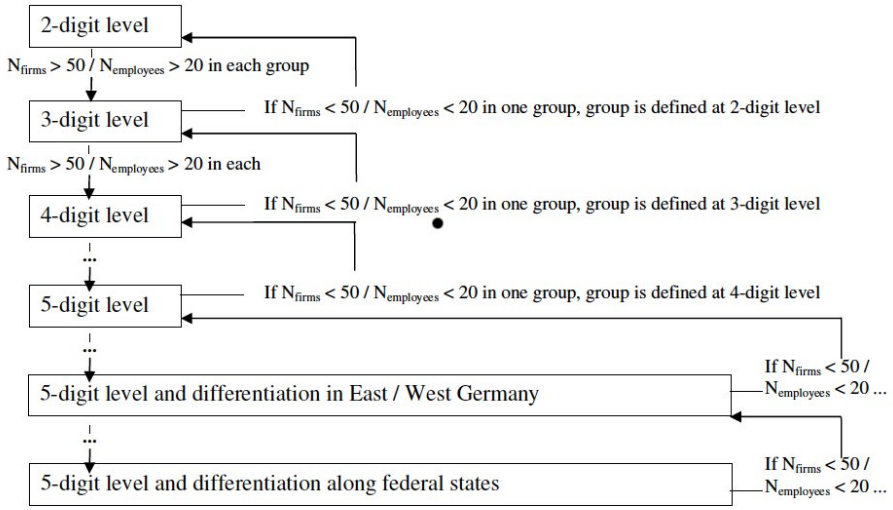
The fraction of the number of marginally employed people in, say, January 1999, relative to the number of marginally employed from April to December 1999 in a group is thus assumed to be the same as the fraction we observe for that group in the year 2000.

We expand the data for January, February, and March 1999 by the number of marginally employed people, as imputed previously, and calculate wages for these added observations:

$$\overline{ME_{g,k}^{1999}} = \left(\frac{\overline{ME_{g,k}^{2000}}}{\frac{1}{9} * \Sigma_{l=4}^{12} \overline{ME_{g,l}^{2000}}} \right) * \frac{1}{9} \Sigma_{l=4}^{12} \overline{MEwage_{g,l}^{1999}}, \tag{3.10}$$

where $\overline{MEwage_{g,l}^{1999}}$ $\left(\overline{MEwage_{g,k}^{1999}}\right)$ refers to the average wage of all marginally employed people in month l (k) and group g in year 1999 (or 2000 if the superscript indicates so). As we did previously, we assume the relation of average wages in each month of the first quarter relative to average wages from April to December remain unchanged between 1999 and 2000.

3.8.5 Sequential procedure for constructing the pseudo-panel



3.8.6 First stage of the 2SLS regression in column (4) of Table 2

	$ATR_{g,t-1}$	$ATR_{g,t-2}$	$ATR_{g,t-3}$
Simulated $ATR_{g,t-1}$	0.544	0.001	0.000
	(0.034)	(0.002)	(0.001)
Simulated $ATR_{g,t-2}$	-0.001	0.544	-0.001
	(0.001)	(0.034)	(0.001)
Simulated $ATR_{g,t-3}$	-0.003	-0.003	0.708
	(0.000)	(0.002)	(0.028)
$Age_{g,t}$	-0.006	-0.004	-0.003
	(0.002)	(0.002)	(0.002)
Age $squared_{g,t}$	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Share of $women_{g,t}$	-0.023	-0.028	-0.009
	(0.008)	(0.009)	(0.007)
Share of $foreigners_{g,t}$	0.006	0.013	0.011
	(0.006)	(0.006)	(0.005)
Share of full-time $employed_{g,t}$	-0.001	0.003	0.001
	(0.001)	(0.001)	(0.001)
Constant	0.000	0.025	0.000
	(0.000)	(0.002)	(0.000)
R^2	0.773	0.774	0.856
Number of observations	4,283	4,283	4,283
F-Statistic	463.03	457.81	501.91
Partial R^2	0.293	0.295	0.494

Notes: Standard errors are reported in parentheses. Calculations of the partial RÂš are described by Shea (1997) and Godfrey (1999).
Source: Own calculations based on Institute for Employment Research, aggregated data from the historical files, 1999 to 2006, German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998, 2001, and 2004, value added tax statistics 1998 to 2006, local business tax statistics 1998, 2001 and 2004.

Chapter 4

The incidence of the level and structure of income and labor taxes on wages

4.1 Introduction

During the 1990s many European and other industrialized economies experienced high unemployment rates while tax rates decreased in some countries and increased in others. In 1995 the OECD jobs study (OECD, 1995) set the spot light on taxation and (un)employment. The linkages between different kinds of taxes on labor (payroll and income tax), the structure of taxes (average rates versus marginal rates) and labor market outcomes were discussed. At the time it was debated how to design tax systems in a way that wages would be pushed down, aiming at an employment boost. The so-called "public finance solutions for the European unemployment problem" (Sœrensen et al., 1997) included proposals to reduce social security contributions or average taxes and alter the tax system's degree of progressivity.

Under common assumptions supporters of labor market theories based on perfect competition as much as economists in favor of imperfect labor market models agreed on the wage-increasing effects of average income tax rates. While predictions about payroll tax incidence already gave greater cause of debate, the main bone of contention was the role of marginal tax rates. Changes to progressivity through adjustments of the marginal tax rate entail appealing features. Ex ante it is possible to change marginal tax rates holding tax payments per employees constant. If wages change in response to

the marginal tax rate, the desired labor market outcome could be reached at low costs. Changes to tax progressivity were thus regarded as the closest realization of a budget neutral labor market policy, so to say a free lunch for labor market policy, and therefore politically a way more feasible scenario than changing the level of average tax rates.

What made the topic so contended is the fact that particularly with regard to marginal tax rates, perfect and imperfect labor market theories yield exactly opposing predictions about the effects of progressivity on wages. Imperfect labor market theories like wage bargaining and efficiency models find a "wage moderating effect of progressivity". Traditional models of perfectly competitive labor markets lead to the opposite recommendation predicting wage-increasing effects of progressivity, also referred to as the "labor supply effect of progressivity".

Several empirical studies set out to test the effect of the different taxes and their structure on wages. While earlier empirical evidence found support for the predictions of wage bargaining theories, this has been contested by more recent studies. Despite the de-unionization observed in Germany in the past several years, collective agreements still play an important role in wage setting and particularly the right-to-manage model has been considered a fairly close description of the wage regime in place (Nickell and Wadhwani, 1991; Bach and Wiegard, 2002; Ochel, 2005). So far there is little evidence on the effect of tax progressivity and the structure of taxes on wages in Germany in recent years; yet for the second half of the 1980s Schneider (2005) finds support for the wage moderating effect of marginal income taxes with stronger effects in the lower part of the pre-tax wage distribution in West Germany.

Between 2001 and 2006 considerable changes to the income tax schedule and some unprecedented changes to the payroll tax system have taken place. I estimate the effect of progressivity of payroll and income tax on wages using these variations in statutory rates and test the predictions of the work horse model of wage bargaining with taxes. Based on a highly detailed microsimulation model (STSM) that considers the actual household context and income types other than labor, average and marginal rates for the different tax rates are computed for each employed individual. This approach thus goes beyond standard tax functions or simplified tax calculations for certain socioeconomic types of employees. In contrast to the income tax rates commonly employed in the literature I consider the overall tax load on the employee accounting for the total tax

load. This constitutes a more complete measure of the tax burden on labor income and avoids omitting an essential part of the tax load that is most likely correlated with other tax variables and wages. Given the progressive character of the income tax system and the regressive nature of the payroll tax system this is also very relevant for the structure of variation in marginal tax rates.

I tackle the well-known endogeneity problem in the tax variables following the approach developed by Gruber and Saez (2002). Aging all income relevant variables a year ahead and applying the tax code of that year to the inflated tax base, counterfactual tax rates are computed and implemented as instruments. The instrument variable thus captures the tax load an individual would have faced in a particular year had he or she not responded to changes in the tax schedule. Estimation in first differences factors out any observed or unobserved time-constant individual effects.

Wage bargaining theories attribute an influence to the level of income received in case of unemployment on the wage outcome of bargaining. Instead of using some aggregate or indexed measure of unemployment benefit I simulate for each employee the counterfactual unemployment assistance he or she would receive in case of unemployment.

Estimation results support the wage-decreasing effect of marginal tax rates while the model's predictions in its strict form are clearly not confirmed; contrary to the model, estimates show a differential impact of employer payroll tax progressivity versus the overall tax progressivity on the employee's side. While the average tax load on employees has no significant impact on consumer wages, there is some evidence that average employer payroll tax is shifted partly onto consumer wages but this is not consistently significant across different samples. With regard to marginal tax rates on the employee side heterogeneous effects prevail. When the effect of progressivity is allowed to vary between high and low-wage employees higher marginal rates have a wage-reducing effect in the lower part of the distribution. In the upper part of the wage distribution the effect is positive.

The next Section reviews the theoretical and empirical literature in the field and a simple model of wage bargaining with taxes is presented in Section 4.3. Section 4.4 explains the estimation strategy, the variations in tax rates used for identification and the instrumental variables (IV) strategy employed. The data, the tax-benefit microsim-

ulation model STSM and descriptive statistics are presented in Section 4.5 followed by estimation results (Section 4.6) and the conclusion.

4.2 Literature

Labor market models capable of explaining involuntary employment as an equilibrium phenomenon, such as union wage bargaining, search, and efficiency wage models, claim that progressivity has a negative effect on wages (Sœrensen et al., 1997). This is in stark contrast to the predictions of the competitive labor market model (Bovenberg and van der Ploeg, 1994).

In a right-to-manage model unions consider the trade-off between higher after-tax wages for the employed and lower overall employment levels, while working hours are given exogenously. If benefits and the marginal tax rate are kept constant, a rise in the average tax implies a rise in the net replacement ratio and unions push for higher pre-tax wages because net income loss from employment is reduced. With constant average tax, a higher marginal tax rate makes it less costly for the union to "buy" additional jobs through wage moderation; the marginal tax increase leads to lower after-tax wages and the purchase of higher employment leads to a slighter decrease in after-tax wages compared to the initial situation. This even holds for the particular case of a union whose utility only depends on the wage rate and not on the employment level of its members (seniority model of union preferences). While the firm's payoff is not altered by higher marginal tax rates, a given wage increase is less desirable for the union compared to the initial situation with lower marginal taxes. This mechanism is referred to as the *wage moderating effect of progressivity* in imperfect labor market models (see Holm et al. (1994); Koskela and Vilmunen (1996); Koskela (2001); Goerke (2002b)). One of the theoretical models most commonly referred to in the empirical literature (mainly developed by Holmlund and Kolm (1995a) and Lockwood and Manning (1993)) is presented in Section 4.3.

In the perfectly competitive labor market model workers can vary hours and aggregate employment is typically measured as overall hours worked. An increase in the marginal tax rate holding the average rate constant reduces labor supply at a given pre-tax wage as individuals substitute work for leisure. In consequence the market-clearing

wage has to be increased. This has become known as the *labour supply effect of progressivity*.

Hansen et al. (2000) pick up on the role of the intensive margin in a union bargaining model. They show that when wage bargaining is not only on wages but also on hours, the traditional union-wage bargaining result with regard to average wages still holds; but the effect of a change in marginal tax rates is theoretically undetermined and depends on the magnitudes of the union's bargaining power, the elasticity of labor supply, and the employment cost of higher wages.

The wage bargaining literature predicts effects of payroll tax levied on the employer's side just as analogous to those of the income tax. In competitive models the incidence of the payroll tax depends on the elasticities of labor supply and demand, the tax-benefit link (valuation of future benefits by employees) and the true firm cost of the tax.

Goerke (2002a) shows how different tax levels and changes to the tax structure behave in different types of imperfect labor markets and emphasizes the role of different assumptions with regard to, inter alia, the nature of the union and the indexation of benefits. Koskela and Schöb (1999) and Goerke (2002a) have shown theoretically that in the scope of a revenue-neutral shift from payroll tax to income tax the structure of taxation should not be neglected. They challenge empirical work to better account for different types of taxes and more complete measures of tax load.

Empirical literature on payroll incidence is based on evaluation type studies (difference estimator, differences-in-differences(-in-differences) estimation, regression discontinuity design) except for the very early macro studies and focuses solely on average payroll taxes. Most of the studies based on micro data find full or partial shifting to wages. Studies that also look at employment normally find nearly no effects on employment and full shifting onto wages (see i.e. Anderson and Meyer (1998); Gruber (1997); Gruber and Krueger (1990); Kugler and Kugler (2009); Mitrusi and Poterba (2000); Ooghe et al. (2003)). In a recent study Saez et al. (2011) analyze for Greece based on a regression discontinuity design a large increase in payroll taxes for employees that entered the labor market in 1993 or later. They find that employers compensate employees for extra employer payroll taxes, but not for the employee side taxes. They detect no evidence for labour supply responses along the extensive or intensive margins.

The empirical literature on progressivity sometimes also includes estimates of the effects of the average payroll tax rate alongside the progressivity analysis. The studies including payroll taxes alongside income tax variables find with the exception of Brunello et al. (2002) a negative effect of payroll taxes on gross wages. Average tax rates are found to have a positive albeit not always significant impact across all studies.

Studies based on macro/time series data are mostly supportive of the wage moderating effect of tax progression brought forward by theories of imperfectly competitive labor markets. Tax rates are typically instrumented with their own lag and time trends. For the UK Lockwood and Manning (1993) confirm the wage moderation hypothesis of imperfect labor market models; Holmlund and Kolm (1995a) find support for the wage bargaining model at different earnings levels for the case of Sweden (for a survey see Sœrensen et al. (1997)). Approaching the issue from a different angle and emphasizing the role of work effort Blomquist and Selin (2008) find for a similar period the same qualitative results when looking at the net-of-tax rate (1 minus the marginal tax rate).

Other studies contest these results. Lockwood et al. (2000) confirm a heterogeneous effect of wage progressivity across the income distribution; while middle-income workers see a wage decrease due to higher progressivity, high-income earners benefit from increased pre-tax earnings. Brunello et al. (2002) derive individual average and marginal tax rates and find wage-increasing effects of progressivity for estimation of a panel in changes as much as with grouped data for Italy. Tranæs et al. (2006) broach the issue of endogeneity and argue that progressivity in aggregate time series is positively correlated with income by construction. Under the assumption that marginal tax rates exhibit very little variation but that productivity increases over time, the productivity driven rise in labor income translates into higher average tax rates while marginal tax rates remain constant. Progressivity thus is positively correlated with income not necessarily due to behavioral response as predicted by non-competitive labor market theories but by construction according to the authors point out.

Tranæs et al. (2006) propose estimated tax functions as an alternative instrument instead of lagged tax rates or simple computations of individual marginal tax rates for certain socioeconomic types of workers. They emphasize that estimated tax functions also allow to better account for subsidies. Based on data for Copenhagen their results estimated in first differences or differences-in-differences in general support the com-

petitive labor market hypothesis. Yet the wage-increasing effect is not significant for all sub-groups, particularly not for the lower occupational groups. They furthermore stress the role of business cycles and put into perspective their main result; during recession when the risk of unemployment is high, unions moderate wages relative to outside wages in view of greater tax progression.

For Germany, Schneider (2005) builds on a monopoly union model that differentiates between high and low-skilled workers and estimates the empirical relationship based on individual-level data from the GSOEP. She finds a wage-reducing effect of progressivity in the 1980s which turns out stronger for employees in the lower part of the wage distribution.

Magnitudes of estimates vary considerably between studies even within those either supporting the competitive or the imperfectly competitive labor market hypothesis. Schneider (2005) finds the average tax rate elasticity of wages to equal 0.31, and a marginal tax rate elasticity of -0.18. Brunello et al. (2002) estimate the elasticity of wages with regard to the average (marginal) tax rate to be between 0.17 (0.92) and 0.52 (1.13) depending on their sample design. Lockwood et al. (2000) find that a 1 percentage point increase in the marginal tax rate increases the wage by 0.7 percent for the socioeconomic group of male white collar workers in the upper earnings quartile. For middle-income earners (defined as unskilled workers, high-wage women and low-wage white-collar men) such an increase in marginal tax would in contrast decrease wages by 3.9%, a magnitude the authors themselves deem as "quite substantial".

The majority of studies and particularly the more recent studies use individual level data. Some authors consider only marginal income tax rates, other also consider average tax rate and (employer) payroll tax. The studies use yearly labor income or the hourly wage rate as the left hand side variable raising the question how comparable results based on these distinctly different measures of wage income are given the potential role of adjustments on the intensive margin of labor supply. Yet in the empirical literature hours worked has been found to be quite inelastic with regard to marginal tax rates for those already working (see i.e. Heckman (1993); Flood and MaCurdy (1992); Blundell et al. (1998); Blomquist et al. (2001)) reassuring these doubts.

4.3 A wage bargaining model with taxes

In an economy where hours of work are fixed and normalized to unity, employment is exclusively set by firms in view of the wage bargaining result reached in negotiations with the union. Following Holmlund and Kolm (1995a) indirect taxes are not explicitly modelled as their effects correspond to the effects of proportional income tax and do not need to be explicitly introduced.[1] The firm has to pay payroll taxes $E(W_i)$ on top of the wages it pays out to its employees, W_i, such that the real producer wage amounts to $W_i^p = \frac{W_i + E(W_i)}{p}$. The elasticity of the producer wage with regard to the gross wage equals

$$\frac{\partial W_i^p}{\partial W_i}\frac{W_i}{W_i^p} = \left(1 + E'(W_i)\right)\frac{W_i}{W_i + E(W_i)},$$
$$\nu_E \equiv \frac{1 + E(W_i)/W_i}{1 + E'(W_i)},$$

and payroll progressivity, ν_E, equals its inverse. The elasticity of the firm's profit and employment with regard to the real producer wage (ε_π and ε_N) are negative.

Employees are paid the wage negotiated between the union and the firm, W_i. The real consumer wage employees finally care about, W_i^c, is the real value of the negotiated wage net of the amount employees are taxed according to tax schedule $H(W_i)$ that includes all tax loads on the employee's side, namely income tax and social security contributions.[2] This leaves them with after-tax consumption wage $W_i^c = \frac{W_i - H(W_i)}{p}$. The elasticity of the after-tax consumption wage with regard to the wage paid out to the employee is given by

$$\frac{\partial W_i^c}{\partial W_i}\frac{W_i}{W_i^c} = \left(1 - H'(W_i)\right)\frac{W_i}{W_i - H(W_i)}$$
$$\nu_H = \frac{1 - H'(W_i)}{1 - H(W_i)/W_i},$$

[1] The following exposition is based on the models by Lockwood and Manning (1993) and Holmlund and Kolm (1995a). For further details on the derivations see the Appendix.

[2] For simplicity this will be referred to as income tax in the model exposition.

where ν_H is known as the familiar measure of progressivity developed by Musgrave (also referred to as the coefficient of residual income progression, RIP). Progressivity increases as ν_H approaches zero and the tax system is regressive if $\nu_H > 1$.

In a right-to-manage model the wage is determined through bargaining between a union and a firm (or a number of identical firms in a particular sector represented by an employer organization). Employment is set unilaterally by employers after wages have been agreed upon; employment lies thus on the labor demand curve.

The trade union's general utility is $\Gamma(N_i, W_i^c) = N_i^{\gamma}[U(W_i^c) - \Gamma_0]$. $U(W_i^c)$ is the union member's utility drawn from his labor income and Γ_0 stands for the utility in case of job loss. Union membership is exogenously given and unions cannot influence Γ_0. The elasticities of the union's utility with regard to the real consumer wage and employment (θ_{W^c} and θ_N) are positive and the latter equals $\theta_N = \gamma$. As a special case isoelastic utility is considered, $U(W_i^c) = (W_i^c)^{\delta}/\delta$, where $\theta_{W^c} = \frac{\partial \Gamma}{\partial W^c}\frac{W^c}{\Gamma} = \frac{(W^c)^{\sigma}}{(W^c)^{\sigma}/\sigma - \Gamma_0}$.

This general formulation of union utility encompasses not only risk-neutrality ($\delta = 1$) and risk-aversion ($\delta \leq 1$). It also covers two prominent cases of union preferences. A utilitarian union (see for instance Oswald (1982) amongst others) simply adds up the utility of each employed member ($\gamma = 1$). It thus indirectly attaches value to employment while not bargaining directly over the size of the work force like in the efficient bargaining model. A competing model of union preferences is the seniority model, a strong form of insider-dominated union (Oswald, 1985), i.e. $\gamma = 0$. In this model workers loose their jobs according to the last-in first-out firing rule and the median union member is considered to be isolated from job loss. As the more senior union members dominate the voting and assuming the median union member's probability of employment to equal unity, the union attaches no weight to employment in its utility.

The wage is chosen to maximize the asymmetric Nash bargain $(\Gamma_i - \underline{\Gamma})^{\lambda}(\Pi_i - \underline{\Pi})^{1-\lambda}$ where $0 \leq \lambda \leq 1$ captures the bargaining power of the union relative to the employer's bargaining power, and $\underline{\Gamma}$ and $\underline{\Pi}$ the fall-back payoffs of the union and the employer in case no agreement is reached. The negotiated wage W_i maximizes the Nash product

$$\Psi = \lambda ln(\Gamma_i - \underline{\Gamma}) + (1-\lambda) ln(\Pi_i - \underline{\Pi}).$$

and the first order condition evaluates to

$$\begin{aligned}\Psi_W =& \lambda \frac{\Gamma}{\Gamma - \underline{\Gamma}} \left\{ \theta_N \varepsilon_N \left(\frac{1+E'(W)}{1+E(W)/W} \right) + \theta_{W^c} \left(\frac{1-H'(W)}{1-H(W)/W} \right) \right\} \\ &+ (1-\lambda) \frac{\Pi}{\Pi - \underline{\Pi}} \varepsilon_\pi \left(\frac{1+E'(W)}{1+E(W)/W} \right) = 0 \\ & \lambda \frac{\Gamma}{\Gamma - \underline{\Gamma}} \left\{ \theta_N \varepsilon_N \nu_E^{-1} + \theta_{W^c} \nu_H \right\} + (1-\lambda) \frac{\Pi}{\Pi - \underline{\Pi}} \left\{ \varepsilon_\pi \nu_E^{-1} \right\} = 0.\end{aligned}$$

With fall-back profits set to zero ($\underline{\Gamma} = \underline{\Pi} = 0$) and using the fact that with isoelastic utility $\theta_{W^c} = \frac{(W^c)^\sigma}{(W^c)^\sigma/\sigma - \Gamma_0}$, the wage equation becomes

$$(W^c)^\delta = \left[\frac{1}{\delta} - \nu\kappa \right]^{-1} \Gamma_0,$$

where $\nu = \nu_H \nu_E$ and κ is a broad constant of wage bargaining power
$\kappa = -\lambda \left[\lambda\gamma\varepsilon_N + (1-\lambda)\varepsilon_\pi \right]^{-1} = \lambda \left(1-\alpha'\right) \left[\lambda\gamma + (1-\lambda)\alpha' \right]^{-1}$.

Furthermore define workers' outside option as a weighted combination of the wage and the real benefits a household would get in case of unemployment, where the weights are defined by the probability to be reemployed:
$\Gamma_0 = \left[1-\psi(u)\right](1/\delta)\left(W^c\right)^\delta + \psi(u)(1/\delta')B^{\delta'}$. Benefits B are independent of the negotiated wage and state specific utility functions allow for the utility value of benefits to differ from the utility value of real wages. Worker's outside option is different from $\underline{\Gamma} = \Gamma(N_i, W_i^c) = \Gamma(0, W_i^c) = 0$, the union's fallback option, that entails that union's utility is zero if no agreement is reached because no union member will be employed.

Under these additional assumptions the real consumer wage becomes a function of benefits:

$$(W^c)^\delta = B^{\delta'} \left[\frac{\delta'}{\delta} - \frac{\nu\kappa\delta'}{\psi(u)} \right]^{-1}. \tag{4.1}$$

Equation (4.1) predicts that the tax variables affect the real consumer wage only through progressivity. Furthermore marginal income tax rates unambiguously reduce the consumer wage in this framework even if no specific form of utility and worker's outside option would have been assumed (see Lockwood and Manning (1993, p. 7), Bovenberg and van der Ploeg (1994, p. 16)). Goerke (2002b, p. 75 ff.) points out that in

right-to-manage models in general the wage-decreasing effect of marginal income tax rates also takes place in case of a monopoly union as long as it attaches some value to employment ($\lambda = 1$ and $\gamma > 0$) and a seniority union that is not wage-setting ($\lambda < 1$ and $\gamma = 0$). Intuitively a higher marginal income tax rate does not change the firm's payoff. It also leaves the difference between the net wage and the outside option in the union's decision calculus unchanged for a given wage. Yet from a given wage increase less of such an increase translates into after tax wages (and finally union utility) with higher marginal tax rates. Higher marginal tax rates therefore make a given wage increase more costly to the union compared to employment. Altogether the union basically trades a given wage increase for more employment, a pure substitution effect (Lockwood and Manning (1993, p. 7), Goerke (2002b, p. 76)).

For the marginal payroll tax a similar reasoning applies. While the firm's payoff is unaffected by the increase in marginal tax, it still makes a given wage increase less attractive to the union compared to the initial level of marginal tax (see Goerke (2002b) and Holmlund and Kolm (1995b)). A given rise in wages would reduce employment and therefore make lower wages more attractive to the union on the margin. A higher marginal payroll tax furthermore lowers the firm's gain from bargaining at the margin and in case that the firm has non-zero bargaining power the rent bargained over is split differently than in the initial situation and finally reduces the wage.

In the particular setting of equation (4.1) a quite surprising prediction with regard to average tax rates arises; an increase in average tax rates holding the marginal tax rate constant, increases ν_E or ν_H, and has a positive effect on consumer wages. As the elasticity of the consumer wage with regard to the producer wage equals ν, an increase in the average tax rate results in a more inelastic labor demand which finally drives up consumer wages (see Lockwood and Manning (1993, p. 9)). This result is proprietary to the combinations of assumptions made in the models by Lockwood and Manning (1993) and Holmlund and Kolm (1995a), and is not a general result for right-to-manage models. Whether an increase in average tax rates has a positive or negative effect on (consumer) wages hinges on the combination of restrictions imposed (Goerke, 2002b, p. 68 ff.), like union preferences, bargaining power and the utility function. For average payroll tax most combinations of assumptions lean towards a wage-reducing effect according to the same author. He points out that the restrictions set out in the model above are a

quite peculiar case with regard to the relationship between labor demand elasticity, the level of firm's fall-back profits and the ratio of payroll to profits.

Setting $\delta^* = \delta^{'}/\delta$ as the relative measure of risk aversion in the employed's utility versus the unemployed's utility function and assuming that the probability of job loss is linear in aggregate unemployment leads to

$$\begin{aligned} W^c =& B^{\delta'} \left[\frac{\delta'}{\delta} - \frac{\nu\kappa\delta'}{\phi u} \right]^{-\frac{1}{\delta}} = B^{\delta^*} \delta^{*-\frac{1}{\delta}} \left[1 - \frac{\nu\kappa\delta}{\phi u} \right]^{-\frac{1}{\delta}}, \\ ln(W^c) =& -\frac{1}{\delta} ln\delta^* + \delta^* lnB - \frac{1}{\delta} ln \left[1 - \frac{\nu\kappa\delta}{\phi u} \right]. \end{aligned} \tag{4.2}$$

4.4 Identification

4.4.1 Identifying the effects of taxes on wages

Setting the above equation in a log-linear fashion yields [3]

$$ln(W^c) = \beta_0 + \underbrace{\beta_1}_{+} ln(\nu) + \underbrace{\beta_2}_{+} ln(B) + \underbrace{\beta_3}_{-} ln(u) + \underbrace{\beta_4}_{+} ln(\kappa), \tag{4.3}$$

where κ is empirically approximated by the sectoral level of wage bargaining coverage, u is defined as unemployment on a regional level. The bargaining power and benefits have a positive impact on the consumer wage, unemployment affects it negatively. In a more general formulation of the above equation the theory's predictions about the different types (payroll vs. income tax) and the structure of taxes (marginal vs. average

[3] Log-linearizing the model's wage equation does not yield a solution suitable for estimation as the last term in square bracket of equation (4.2) cannot be broken up; progressivity, the bargaining indicator and the unemployment rate thus do not end up separately in logs.

tax rates) can be tested:

$$\begin{aligned} ln(W^c) =& \beta_0 + \underbrace{\beta_{11}}_{+} ln(1+E(W)/W) + \underbrace{\beta_{12}}_{-} ln(1+E'(W)) \\ &+ \underbrace{\beta_{13}}_{+} ln(1-H'(W)) + \underbrace{\beta_{14}}_{-} ln(1-H(W)/W) \\ &+ \underbrace{\beta_2}_{+} ln(B) + \underbrace{\beta_3}_{-} ln(u) + \underbrace{\beta_4}_{+} ln(\kappa). \end{aligned} \tag{4.4}$$

The predicted signs for the marginal tax rates alone are thus negative, those for the average tax rates positive for the theory to hold based on the particular assumptions of the model. If the model presented above holds, equation (4.4) reduces to a special case of (4.3) where $\beta_{11} = -\beta_{12} = \beta_{13} = -\beta_{14}$. This entails not only that marginal and average tax rates exhibit opposite signs but that they are also of the same magnitude for the two different tax types. If this holds only the non-proportionality of the tax system would matter. Payroll tax progression and income tax progression can also be entered separately to test whether they have a differential impact.

Unfortunately the aggregation of a pseudo-panel on a sectoral level based on GSOEP's individual-level data proves difficult as the sample size is not large enough and the industry level break-up not deep enough. Moreover the data are not stratified along employees' industry affiliation in first place and an aggregation may risk to produce non-representative data. Estimation in first differences purges individual time-constant effects and also takes out firm and industry level fixed effects relevant to wages, like firm size and varying pay levels across industries. At the expense of not estimating on a sectoral level an analysis on the individual level has advantages in two dimensions; For one, perfect labor market theories vouch for wage-increasing effects of marginal tax rates and model the wage decision on the individual level. Moreover did other studies in the field find differential impacts along the wage distribution which can be implemented more easily with individual data splitting the sample at different points of the distribution. To ensure that results are not driven by employees switching employer and/or industry, the sample is restricted to observations with at least twelve months of tenure as a robustness check (see Table 4.4).

4.4.2 The Social Security and income tax system in Germany

The compulsory Social Security in Germany refers to four different branches; (1) the old age pension scheme, (2) the health and long term care insurance, (3) the unemployment insurance.[4] Apart from marginal employment and the so called *midi jobs*, contributions increase proportionally with labor income up to respective assessment ceiling and are shared between the employer and the employee. For the unemployment insurance the old age insurance assessment ceiling is employed. The assessment ceiling for the old age insurance was at, i.e. €63,000 (€54,000) of yearly income in West (East) Germany in 2008. It is uprated on a yearly basis in view of last year's gross wage development. The assessment ceiling for the health insurance was €43,200 in 2008. In 2008 the statutory contribution rate for employers and employees combined amounted to 19.9% of gross wages towards the old age insurance, roughly 14% towards health insurance, 1.95% towards long term care insurance and 3.3% towards the unemployment insurance.

While contributions for the old age insurance are compulsory for everyone not marginally employed, employees can opt out of the compulsory insurance if they earn beyond the earnings ceiling for the public health system. Up until 2002 this coincided with the assessment ceiling but was split from it since 2003 when it was uprated by 13.3%. In 2005 an additional contribution was levied on top of the health insurance which was to be paid by employees while decreasing the employer's contribution at the same time. Since then the overall statutory contribution is not anymore split evenly between employers and employees anymore.

The employer's contribution for the marginally employed changed frequently in the time span observed. In April 2003 the restriction of no more than 15 working hours per week was lifted and employers had to pay 25% of the gross wage towards social security for employees earning up to €400 per month. At the same time *midi jobs* were introduced to smooth the jump in contributions between marginal employment and normal employment. For employees remunerated between €400 and €800, contributions of employers drop to the common level (20.85%) and employees contributions increase

[4]The accident insurance also belongs to the Social Security system. Contributions are paid by the firm and depend only in part on the firm's wage bill as employers' risk rating also decides on the amount to be paid. The accident insurance will not be considered here.

linearly towards 20.85%. Variation between individuals in terms of payroll tax thus arises due to the assessment ceiling and the differential treatment of marginal employment and *midi jobs*.

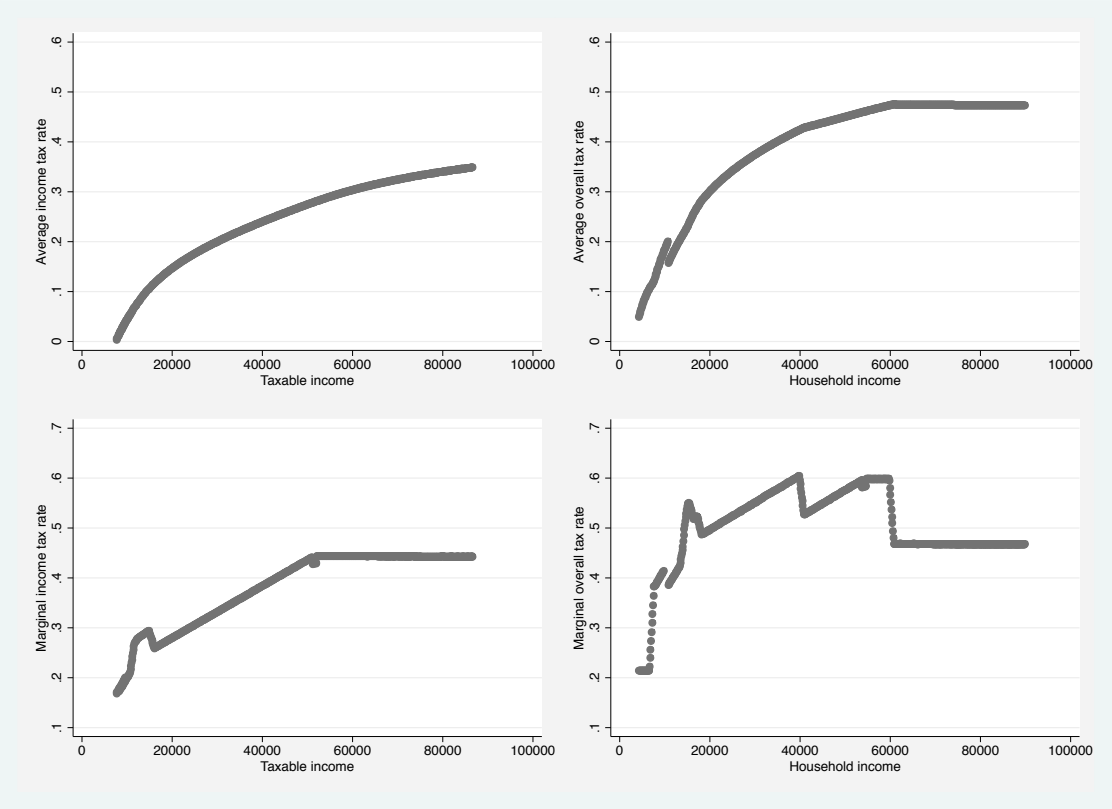
For assessment of the income tax on the household level, the household's different incomes are summed up and several deductions subtracted from the tax base. Some incomes make part of the taxable income based on which the average tax rate is calculated (*zu versteuerndes Einkommen 2 (zvE2)*) but are not considered in the tax base for which the final tax load is assessed (*zu versteuerndes Einkommen 1 (zvE1)*). Moreover, most married couples file for joint taxation where the income tax rate stems from applying the tax function to half the household's taxable income. The resulting amount is then doubled and constitutes the income tax load finally to be paid by the household.

While the income tax function is smooth, the marginal income tax rate when referring to a marginal increase in labor income and not taxable income takes some unexpected turns. E.g. as social security and other kinds of provident expenses (*Vorsorgeaufwendungen*) can be offset only up to a certain amount, it is even possible for the marginal tax rate to turn negative at certain levels of initial taxable income.

The largest reform of income and corporate taxation in Germany since WWII was passed in 2000 (*Steuerreform 2000*). The objective was to reduce the tax burden for both, companies and private households to boost growth and employment of the economy. Beginning in 2001 the top (lowest) marginal personal income tax was reduced from from 51% (22.9%) to 42% (15%) in 2005, and the tax allowance increased from €6,902 to €7,664. In 2007 an additional top tax bracket was introduced (*Steueränderungsgesetz 2007*) that applies a tax rate of 45% to taxable incomes beyond €250,000.

Apart from the variation in income taxes across time, marital status, the number of children in the household, other household members' income and non-labour income lead to variation in taxable income and thus income tax rates between individuals. The overall financial situation of households is characterized by social security and income tax payments on the one hand, and by a variety of transfers such as child and parental leave benefits, home-owner subsidy, commuter tax allowance. Figure 4.1 captures graphically the differences between considering the structure of the income tax alone or focusing on the overall tax load on the employee that accounts for all kinds of taxes on labor on the employee's side. It shows at different levels of taxable income,

Figure 4.1: Differences in tax structure between income tax and overall tax load



Notes: Tax rates and progressivity for different levels of labor income of a hypothetical person when keeping everything else constant. For convenience negative marginal tax rates are excluded in the schematic plot.
Source: Own calculations.

the structure of income taxes as opposed to the the structure of the overall tax load for a hypothetical single man. Under the assumption that he only has labor income and is not eligible for any subsidies, tax rates for different levels of labor income were simulated. While the average overall load exhibits a smooth shape similar to average income tax (top row), the path of marginal tax rates (middle row) is less steady for the overall tax load.

The peculiar twists and turns of the marginal tax rates are connected to critical points i.e. in the level of labor income for the assessment of social security or the level of taxable income. As the overall tax load combines all kinds of tax payments levied on labor income, it mirrors the interaction of the different institutional rules that make up the German tax and transfer system. I.e. in the second row the decrease in the

marginal income tax rate between taxable income of roughly €15,000 and €16,000 is due to the fact that coming from this level of taxable income the marginal increase in income actually leads to a decrease in the amount of deductible provident expenses. This reduction in the marginal tax rate also carries over to the overall marginal tax load in the middle panel in the right column. The steep increase in the marginal tax rate to the left captures when the increase in labor income entails that the person would have to pay income taxes by passing the tax allowance threshold. Just beyond €40,000 (€60,000) the assessment ceiling for the health (old age) insurance is reached. Marginal overall tax rates again increase between roughly €40,000 up till €52,000, the end of the progression zone where the tax schedule levels out. Beyond €60,000 the marginal social security tax rates are zero and the marginal overall tax rate is driven by the income tax schedule.

4.4.3 Instrumental variable estimation

Labor income constitutes a large part of the income tax base and is equivalent to the payroll tax base up to the assessment ceiling. Income and payroll tax rates are calculated as a function of the respective tax base. Therefore they are clearly prone to endogeneity problems as tax rates can be influenced by employer's as much as individual's behavioral responses to the tax code. Moreover tax rates correlate not only with individual effects but also contemporaneous macroeconomic shocks as they may introduce correlated deviations between wage rates and taxable income. Valid instruments are thus needed for the different tax variables.

Appropriate instrument variables as proposed by Gruber and Saez (2002) are implemented to solve the endogeneity problem. Each individual's marginal and average tax rates in year t are instrumented with the simulated tax rates he would have encountered if his tax base had not endogenously changed between $t-1$ and t. This is achieved by aging all income-relevant variables from year t one year ahead with the overall economic growth rate exogenous to the individual's decision and applying the tax code actually in place in year $t+1$ based on STSM. Only variation in the tax laws and economic developments exogenous to the individual is thus used for identification. A couple's decision, e.g., to marry just before a tax code change makes marriage even

more attractive, is instrumented by predicting their individual tax rates if they had not married.

Apart from instrumenting the potentially endogenous tax rates, the equation of interest is estimated in first differences to take care of person fixed effects. This also takes out most of the variation on the individual level connected to wages, like experience, age, tenure, occupation.

If a person did not switch employer, person fixed effects account for firm level characteristics linked to wages, like firm size and industry affiliation. As mentioned above the GSOEP does not allow to discern workers' pay scheme (covered by an agreement or not.) Moreover workers' pay under a collective agreement may be differentiated along various dimensions, i.e. skill group, tenure, region of employment etc. Many firms also opt to pay above the bargained wage and other firms that are not member of the employer organization mimic the wage agreement in their pay scheme. Fixed effects allow to back out any peculiarities to the sector or firm that are constant across time provided that the employee did not change the employer.

4.5 Data and the Tax-Benefit-Simulation Model

4.5.1 The German Socio Economic Panel

The analysis is based on the German Socio Economic Panel (GSOEP), a representative sample of over 11,000 private households in Germany (Haisken-DeNew and Frick, 2005). The panel supplies detailed information on labor income as much as other sources of household income. Labor market information, i.e. the type of job, working hours, tenure, and employer characteristics like industry affiliation and firm size is available. The sample is restricted to individuals that make part of the compulsory Social Security system, therefore excluding other groups that are subject to the income tax like the self-employed, civil servants, and retired people. The analysis is furthermore based on data of continually employed people as payroll and income taxes are both assessed on a yearly basis and people receiving unemployment benefits or assistance during unemployment spells shall not be considered in the analysis. Individuals on vocational training are excluded. Gross monthly earnings in the month before the

interview together with the information on hours worked is used to calculate the hourly wage rate and finally together with the tax variables the consumer wage.

The GSOEP does not contain information about the pay scheme for a particular worker (collective, firm, plant level agreement or none of the above). As a proxy variable the degree of coverage by collective agreements on the industry level is added using data from IAB's establishment panel. Furthermore unemployment rates on a regional level (*Raumordnungsregionen*) are introduced as a measure of unemployment probability.

4.5.2 The tax-benefit simulation model (STSM)

The micro-simulation model STSM depicts in great detail the German tax and transfer system. For the study at hand different measures of tax rate are calculated, namely employer payroll tax rates, income tax rates and the overall tax load on the employee's side.

Payroll tax loads are calculated given the employed's yearly labor income and job type (marginal employment, *midi job* or common employment). The income tax payments are assessed in the household context. After adding up all income components of household members certain expenses are deducted and benefits relevant for the income tax are accounted for the calculation of taxable income. The income tax function is then applied directly to taxable income for singles and unmarried couples; for married couples joint taxation is implemented.

Net income is derived as gross income (including social transfers) less income tax and the employee's social security contributions. Social transfers considered on the household level are child benefits, child-rearing benefits, housing benefits, social assistance, education benefits for students, and unemployment compensation. The average income and overall tax rate is the same for a married couple in this framework. But note that the marginal tax rates may differ between husband and wife. Keeping i.e. the husband's income and all other household characteristics stable, a marginal increase in the wife's labor income may be subject to a quite different degree of tax load than in the opposed scenario (increasing the husband's labor income by the exact same marginal amount), given different initial levels of labor income.

For the currently employed in the data each individual's counterfactual UE assistance is simulated in case that he or she would loose their job. Again the simulation takes into account each person's household context.

4.5.3 Descriptive Evidence

Table 4.1 shows the main characteristics of the estimation sample. The majority of observations works full-time and is employed in West Germany. Table 4.2 depicts the main variables of interest and their development over time. Real wages declined over time, a well-known development in Germany for that time span.

Table 4.1: General characteristics of the data set

	2002	2003	2004	2005	2006	2007	2008
Age (in years)	43.79	43.61	43.92	44.08	44.28	44.44	44.67
sd	9.46	9.68	9.39	9.39	9.53	9.60	9.73
Female (in %)	47.45	48.31	48.33	48.53	46.29	47.16	47.53
sd	49.94	49.98	49.98	49.99	49.87	49.93	49.95
Full-time (in %)	81.54	80.80	79.34	80.61	80.74	81.22	80.24
sd	38.80	39.39	40.49	39.54	39.44	39.06	39.83
Vocational training (in %)	69.79	68.80	68.20	68.02	68.60	66.82	65.83
sd	45.92	46.34	46.58	46.65	46.42	47.09	47.44
East Germany (in %)	18.08	18.02	17.70	17.71	17.92	19.17	18.96
sd	38.49	38.44	38.17	38.18	38.36	39.37	39.20

Notes: Sample restricted to employed people with positive income tax payment.
Source: Own calculations based on GSOEP 2002 through 2008.

Average employer payroll taxes remained on average quite stable across time; the decrease of the average and marginal tax load between 2005 and 2006 by nearly one percentage point picks up the decrease in the employer's contributions to the health insurance. Variation in marginal employer payroll tax takes place when the marginal increase in remuneration brings marginal employment on the level of *Midi job*. Also on the employee's side the marginal social security contribution rate changes abruptly here, but changes again when the *Midi job* becomes a normal job. The fraction of low-paid jobs increased over the observation period. On the other side of the wage distribution marginal payroll taxes deviate from average payroll tax rates in two instances, namely

Table 4.2: Descriptive statistics

	2002	2003	2004	2005	2006	2007	2008
Hourly wage rate	14.92	14.93	14.82	14.58	14.39	14.39	14.12
sd	5.27	5.32	5.22	4.91	4.66	4.87	4.77
Hourly wage rate net of income taxes	12.15	12.15	12.22	12.07	11.93	11.84	11.60
sd	3.87	3.94	3.90	3.70	3.59	3.65	3.54
Hourly wage rate net of all tax	9.05	9.01	9.04	8.89	8.73	8.79	8.67
sd	2.96	2.94	2.89	2.71	2.64	2.72	2.64
Average employer payroll tax rate (in %)	20.38	20.65	21.13	21.10	21.17	20.15	19.79
sd	1.21	0.90	1.04	1.40	0.94	1.10	0.83
Average income tax rate (in %)	18.27	18.25	17.02	16.57	16.58	17.05	17.15
sd	5.69	5.75	5.72	5.62	5.50	5.60	5.64
Average overall tax load (in %)	38.65	38.89	38.12	38.15	38.60	38.06	37.83
sd	5.41	5.53	5.57	5.47	5.36	5.37	5.36
Marginal employer payroll tax rate (in %)	19.07	19.51	19.93	20.08	20.03	18.92	18.35
sd	4.43	3.83	4.38	5.48	4.20	4.79	3.89
Marginal income tax rate (in %)	30.87	30.86	30.35	29.18	29.35	29.79	29.86
sd	15.28	13.11	12.54	8.31	8.25	11.98	10.99
Marginal overall tax load (in %)	49.94	50.37	50.35	49.64	50.21	49.46	49.02
sd	15.13	13.10	12.73	8.67	8.80	12.67	11.26
Payroll progressivity (in %)	101.22	101.04	101.12	101.01	101.05	101.17	101.31
sd	3.45	3.00	3.23	3.66	3.09	3.37	3.06
Income tax progressivity (in %)	84.63	84.54	83.91	84.93	84.77	84.63	84.71
sd	18.23	14.53	13.95	8.19	8.87	14.25	12.37
Monthly UE assistance	651	657	657	498	487	474	459
sd	400	402	404	232	223	218	214
Regional unemployment rate (in %)	10.78	11.65	11.60	13.01	11.99	10.21	8.59
sd	4.85	4.84	4.73	4.65	4.40	4.16	3.62
Collective contract (in %)	50.07	48.47	48.26	44.44	45.01	44.16	45.37
sd	20.15	19.45	21.13	20.24	20.44	20.60	21.44
Collective contract, incl. orientation (in %)	72.77	71.74	69.74	65.56	69.12	68.21	69.59
sd	16.00	14.79	16.18	16.14	15.61	15.98	16.04

Notes: Hourly wage rates and UE benefits deflated with CPI to 2002. Sample restricted to employed people with positive income tax payment.
Source: Own calculations based on GSOEP 2002 through 2008.

at the assessment ceiling for the health insurance and for the old age insurance. So for

individuals with a yearly labor income just below the assessment ceiling the marginal payroll tax rate will deviate from the average payroll tax rate.

The tax reform of 2000 changed the tax tariff in steps with the first half of adjustments taking place between 2000 and 2002. The reduction of the average tax rates by about two percentage points in the middle of the distribution of taxable income between 2002 and 2005 also shows up in the empirical tax rates calculated here. The subsequent introduction of a top tax bracket shows for the last years. The starting tax rate saw the greatest change in the tax schedule decreasing by roughly a third between 2002 and 2005; empirically this carries over to a decrease in average income tax from 7.56% to 5.36% for taxable incomes below €20,000. In the tax tariff marginal tax rates with regard to taxable income were reduced across the board. On a smaller scale this feeds through to a decrease in marginal tax rates when considering a marginal increase in labor income. The overall average tax rate that measures all taxes raised on labor income through social security and the income tax is considerably higher at a level of around 38%. It picks up the increase in payroll tax loads on employees during those times with assessment ceilings and contribution rates consistently on the rise except for the last two years where contributions to the unemployment insurance and health insurance were slightly reduced. The marginal overall tax rate shows that on average about 50% of extra labor income are taken away by taxes. The income tax system is clearly progressive with a measure of residual income progression of 0.84 across time. While the payroll tax system is regressive observations with the same level of average and marginal payroll taxes dominate.

For the hypothetical income in case of unemployment different scenarios are conceivable as a lower threat point. If the employee was entirely certain to be reemployed within the next months his income expectations in case of unemployment would be captured by unemployment benefits which can be obtained for a limited number of months only and are a fraction of his last labor income (*Arbeitslosengeld* or respectively *Arbeitslosengeld I*). With greater risk aversion and a less optimistic look at reemployment chances the employee considers long-term unemployment (UE) assistance as his income in case of unemployment.[5] The unemployed are required to rely on their own wealth up to a certain allowance before being entitled to unemployment assistance. If

[5]Before 2005 *Arbeitslosenhilfe* is calculated, from 2005 on *Arbeitlosengeld II*.

one considers wealth in the long run to be used up and neglects partner's (other) income the basic allowance would be non-zero for everyone taking i.e. account of the children in the household. Table 4.2 shows the level of the hypothetical monthly UE assistance based on these assumptions. On average the *Hartz* reforms reduced the level of UE assistance to be expected in case of unemployment but this reduction did not take place uniformly. Depending on each person's situation the hypothetical income level under the new rules could be higher or lower than before the reforms.

Regional unemployment rates are declining from 2005 on. The industry level indicator for coverage by a collective or firm agreement declines over the years.[6] If establishments whose pay scheme is oriented towards the collective agreement are also considered in a wide definition of wage bargaining indicator, the fraction of coverage hovers around 70%.

4.6 Estimation results

Table 4.3 summarizes estimation results for the overall tax load with the OLS results in first differences in the column (1). The dependent variable is the consumer wage as defined in the model above meaning the real after tax wage the employee can actually dispose of. Starting from equation (4.3) the predicted positive impact of ν on consumer wages is found. Higher progressivity thus has a wage-decreasing effect according to column (2). The strength of bargaining and the level of UE assistance have a positive effect on the consumer wage as postulated by theory. In the theoretical wage equation utility is allowed to be state-specific, thus not restricting the parameter δ^* to one. The hypothesis that the point estimate on UE assistance is equal to one is soundly rejected across all specifications. The point estimate for regional unemployment is negative as predicted but not significant. Effects for the non-tax variables are stable across all different specifications to follow. The Durbin-Hausman-Wu test assesses whether the endogenous progressivity variable can in fact be treated as exogenous. The test statistic evaluates to 6.89 (p-value = 0.009) and confirms that the tax variable in fact should be treated as endogenous. Endogeneity remains an issue in the further specifications and is accounted for by 2SLS estimation.

[6]The indicator is computed from the IAB establishment panel for each year.

Table 4.3: Estimation results for income taxes and payroll tax

Dependent variable: ln(real consumer wage)	*FD-OLS* (1)	*FD-2SLS* (2)	(3)	(4)	(5)	(6)
ln ν	0.105	0.281			0.328	
	(0.023)	(0.079)			(0.145)	
ln ν_E			0.933			
			(0.283)			
ln ν_H			0.170			
			(0.088)			
ln(1+($E(W)/W$))				-2.610		-0.443
				(1.700)		(1.534)
ln(1+E'(W))				-0.693		-0.919
				(0.224)		(0.199)
ln(1-($H(W)/W$))				-0.301		-0.675
				(0.210)		(0.265)
ln(1-H'(W))				0.149		0.158
				(0.081)		(0.101)
ln(Real UE assistance)	0.053	0.048	0.044	0.036	0.059	0.036
	(0.008)	(0.008)	(0.007)	(0.011)	(0.008)	(0.012)
ln(Regional unemployment rate)	-0.013	-0.014	-0.014	-0.016	-0.013	-0.014
	(0.020)	(0.020)	(0.020)	(0.021)	(0.020)	(0.020)
ln(Degree of organization)	0.016	0.017	0.016	0.016	0.016	0.015
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Sample size and tax load definitions:						
N	15,100	15,100	15,100	15,100	15,100	15,100
H(W) defined on the level of the ...	overall load	overall load	overall load	overall load	income tax	income tax
Identification:						
Underidentification test statistic	-	14.248	6.142	10.127	6.604	10.032
... p-value in $\chi^2_{(1)}$-distribution	-	0.000	0.013	0.001	0.010	0.002

Notes: Standard errors clustered on industry level are reported in parentheses. Estimates are based on first-differenced data. The dependent variable is the real after tax consumer wage, thus the hourly wage rate in real terms less the respective tax load. In all 2SLS estimations the respective tax rates are instrumented by their simulated counterparts (see text). Year fixed effects and constant included. The terms "average" and "marginal income tax" refer to the pure income tax or the overall tax load on the employee's side (income tax and employee side social security contributions) respectively. The underidentification test follows the methodology proposed in Kleibergen and Paap (2006). Full first stage output for the base specifications in columns (4) and (6) for each instrumented variable is reported in Section 4.8.2 in the Appendix.
Source: Own calculations based on GSOEP 2001 through 2008.

Full first stage output for the benchmark specification in column (4) and (7) is provided in the Appendix. The partial R^2 Shea range between 0.05 and 0.12. Angrist and Pischke (2009, p. 217-218) propose to take the partial R^2 Shea a step further and to actually test whether one of the endogenous regressors is under- or weakly identified when there are several endogenous regressors. Their proposed procedure rejects underidentification for every single endogenous regressor thus supporting the chosen design. The

Kleibergen-Paap test assesses whether the instruments together are adequate to identify the equation (Kleibergen and Paap, 2006) and underidentification as a whole is rejected too.

In a first step the restrictions imposed by the model are relaxed and the two progressivity measures enter separately in column (3). While the point estimates still exhibit the predicted signs, the size of effects is clearly different and the test on equality of coefficients is rejected (χ^2-test statistic = 5.05 with p-value = 0.02). This suggests that the model's hypothesis that the two types of taxes have a uniform effect on consumer wages cannot be accepted. In column (4) the least restrictive version of the model is estimated using the single tax terms that make up overall progression. This means including the marginal and the average employer payroll tax rate, and the marginal and average overall tax load on the employee side separately. The model's restriction that the coefficients on the tax variables are of equal magnitude with opposing signs for marginal and average tax rates, $\beta_{11} = -\beta_{12} = \beta_{13} = -\beta_{14}$, is rejected ($\chi^2$-test statistic = 10.15). The model is therefore clearly not supported by the data.

In the literature it is common to include solely income tax rates on the employee's side alongside the employer side payroll taxes or not considering the latter at all. This approach has some drawbacks as there is good reason to be wary of an omitted variable bias in such a set-up leading to biased estimates and standard errors. There clearly exists correlation between the omitted (employee's) social security contributions and the other tax variables. Most likely (gross and consumer) wages are furthermore not entirely unaffected by the level and structure of employees' social security contributions. While the direction, size and consequences for standard errors of the potential bias due to omitting this variable cannot be pinned down, there is no means to include employees' social security contributions as an additional variable either due to multicollinearity. In the preferred specification in column (4) the overall tax load on the employee's side is therefore considered. Apart from being closer to the theory's definition of the employee's tax load, the overall tax load should also be the economically relevant measure as for many employees the tax load due to social security is substantial and in many cases larger than the income tax load. The chosen approach along the way also circumvents the multicollinearity problem. For completeness columns (5) and (6) report

results when the pure income tax load is considered. Yet compared to the preferred specification significance of the retention rate vanishes.

Table 4.4: 2SLS estimation results for income taxes and payroll tax

Dependent variable: ln(real consumer wage)	(1)	(2)	(3)
ln(1+($E(W)/W$))	-2.610	-3.256	-3.404
	(1.700)	(2.372)	(2.005)
ln(1+E'(W))	-0.693	-0.795	-0.708
	(0.224)	(0.249)	(0.242)
ln(1-($H(W)/W$))	-0.301	-0.248	-0.224
	(0.210)	(0.175)	(0.203)
ln(1-H'(W))	0.149	0.153	0.159
	(0.081)	(0.067)	(0.084)
ln(Real UE assistance)	0.036	0.035	0.036
	(0.011)	(0.012)	(0.010)
ln(Regional unemployment rate)	-0.016	-0.008	-0.005
	(0.021)	(0.018)	(0.023)
ln(Degree of organization)	0.016	0.016	0.013
	(0.006)	(0.006)	(0.005)
Sample size and restrictions:			
N	15,100	14,997	14,752
Only if marginal $>$ average tax	-	yes	-
Only if tenure $>$ 1 year	-	-	yes
H(W) defined on	overall	overall	overall
the level of the ...	load	load	load
Identification:			
Underidentification test statistic	10.127	8.002	13.500
... p-value in $\chi^2_{(1)}$-distribution	0.001	0.005	0.000
Implied tax rate elasticities of consumer wage:			
Average employer payroll tax	-0.446	-0.556	-0.581
	(0.290)	(0.405)	(0.342)
Marginal employer payroll tax	-0.112	-0.129	-0.115
	(0.036)	(0.040)	(0.039)
Average overall tax	0.189	0.156	0.141
	(0.132)	(0.110)	(0.127)
Marginal overall tax	-0.148	-0.152	-0.158
	(0.080)	(0.067)	(0.083)

Notes: Standard errors clustered on industry level are reported in parentheses. Estimates are based on first-differenced data. In all 2SLS estimations the respective tax rates are instrumented by their simulated counterparts (see text). Year fixed effects and constant included. The term "overall tax" refer to the overall tax load on the employee's side (income tax and employee side social security contributions) respectively.
Source: Own calculations based on GSOEP 2001 through 2008.

In Table 4.4 different samples are considered in the benchmark specification and supplemented with the respective tax rate elasticities of the consumer wage. The effects of average payroll tax are on the brink of significance. The sign of the estimated coefficient is clearly at odds with the theory outlined above. As discussed before the prediction of a positive effect of average payroll tax on the consumer wage is not a general characteristic of wage-bargaining models with taxes but rather a feature triggered by the particular assumptions made amongst other things with regard to the fall-back options. Also in a competitive framework employers will shift a rise in the payroll tax on employees' after-tax wages at least partially or even by more than 100 percent (see i.e. (Bovenberg and van der Ploeg, 1994, p. 6)). While not consistently significant the coefficient estimated here would suggest that of a 1 percent increase in average payroll tax roughly half is shifted onto consumers. This is clearly at odds with the predictions made by the theory above yet empirically the shifting of employer payroll tax onto wages has been confirmed before.

The average income tax rate exhibits a positive but insignificant effect on consumer wages with an elasticity of around 0.15. While the notion that average tax rates have a positive impact on gross wages has been found in various studies, this effect did not always prove significant. Moreover does the model that motivated this empirical exercise postulate that there is a positive effect on after-tax wages. Outside the model's context it a priori may appear implausible anyways why employers should absorb more than the initial increase in average tax rates leading to an increase in increase in consumer wages. Such effect cannot be confirmed here and opposes the over-shifting result found by Lockwood and Manning (1993).

Marginal tax rates show the predicted wage-decreasing effect across all specifications. While the negative effect of a one percent increase in marginal payroll tax rates decreases consumer wages by about 0.11, the marginal overall tax rate elasticity equals roughly -0.15. This result confirms the unambiguous prediction of the effect of marginal tax rates in a right-to-manage world and is stable across the different samples. The theory is thus not supported in its claims with regard to the structure of taxes and the role of average tax rates. But the prediction inherent to models of imperfect labor market, that marginal tax rates have a wage-decreasing effect on consumer wages is mirrored by the data.

Studies that estimated the impact of marginal tax rates on before-tax-wages have found effects to differ along the wage distribution, in size or even direction of effects. In Table 4.5 this is followed up for the case of consumer wages splitting the sample at different points. For marginal income tax rates the wage-reducing effect on consumer wage is confirmed for the lower half of the distribution. In the upper half of the distribution the effect becomes positive. This holds for different points of sample split. This opposes results by Schneider (2005) who found significant wage-reducing effects of income progressivity across the whole wage distribution for Germany in the late 1980s. Two points may serve as an explanation: For one did she limit the sample of observations to a sub-group of employees most prone to union membership; for another a considerably larger part of employees was still bound by collective agreements in that period. In these years 72.2% (56.3%) of employees in West (East) Germany were bound by collective agreements according to Kohaut and Schnabel (2003). Fifteen years later the share of coverage had decreased to 63.1% (44.4%).

The findings above are more closely related to the results by Lockwood et al. (2000) who find effect heterogeneity not only in magnitude but also size and significance along the wage distribution. They point out that for different parts of the wage distribution different labor market models may be more apt than others. The study conducted here can be interpreted in a similar way; if the suspected location of wages paid according to a bargaining model is in the lower half of the distribution (remember that coverage by a collective agreement reaches roughly 50% in the sample), the model's predictions on the effects of marginal taxes may be relevant only in that realm. If labor contracts in the upper half of the distribution are set individually between the employer and the employee as commonly reported for the more skilled and better-paid, a competitive labor market would then be the better description for this part of the distribution. Results thus caution against a uniform effect of different taxes and with regard to the effect of taxes along the distribution of consumer wages.

Table 4.5: Estimation results along the wage distribution

Dependent variable: ln(real consumer wage)	(1)	(2)
$\ln(1+E(W)/W)$	-2.244	-1.992
	(1.304)	(1.346)
$\ln(1+E'(W))$	-0.973	-0.771
	(0.177)	(0.175)
$\ln(1-H(W)/W)$	-0.064	-0.034
	(0.151)	(0.178)
$\ln(1-H'(W)) \times$ low	0.156	0.124
	(0.067)	(0.068)
$\ln(1-H'(W)) \times$ high	-0.178	-0.200
	(0.066)	(0.068)
ln(Real UE assistance)	0.018	0.021
	(0.008)	(0.009)
ln(Regional unemployment rate)	-0.013	-0.012
	(0.017)	(0.019)
ln(Degree of organization)	0.016	0.016
	(0.005)	(0.005)
Sample size and restrictions:		
N	15,100	15,100
Sample spit at ...%-percentile of wage distribution	50	60
H(W) defined on the level of the ...	overall load	overall load
Identification:		
Underidentification test statistic	10.197	10.212
... p-value in $\chi^2_{(1)}$-distribution	0.001	0.001
Implied tax rate elasticities of consumer wage:		
Average employer payroll tax	-0.383	-0.340
	(0.223)	(0.230)
Marginal employer payroll tax	-0.157	-0.125
	(0.029)	(0.028)
Average overall tax	0.040	0.022
	(0.095)	(0.112)
Marginal overall tax load $\times$ low	-0.157	-0.126
	(0.067)	(0.069)
Marginal overall tax load $\times$ high	0.175	0.192
	(0.064)	(0.065)

Notes: Standard errors clustered on industry level are reported in parentheses. The dependent variable is the real after tax consumer wage, thus the hourly wage rate in real terms less the respective tax load. In all 2SLS estimations in first differences the respective tax rates are instrumented by their simulated counterparts (see text). Year fixed effects and constant included.
Source: Own calculations based on GSOEP 2001 through 2008.

4.7 Conclusion

A classic in the public finance literature is the role of the level and structure of taxation in wage formation. Theoretical predictions of the traditional competitive labor market model were challenged by theories based on imperfect labor markets in the 1990s. In view of consistently high unemployment rates in many industrialized countries at the time various proposals were made to influence the wage outcome through public finance reforms with the ultimate goal to reduce unemployment. The issue whether marginal income tax rates have a wage-reducing or increasing effect received particular attention. For one because a policy reform affecting progressivity was considered to come closest to a politically feasible budget neutral reform; for another because the benchmark theories of perfect and imperfect labor markets provided clearly opposing predictions. Various empiricists set out to empirically test which theory and finally which policy recommendation is more apt to describe reality. And while earlier studies found support for wage-reducing effects of progressivity this was challenged by the following generation of empirical studies. Not only the direction of effects varies widely across studies but also the magnitude of effects, even suggesting over-shifting of taxes onto wages.

The study undertaken here extends the literature by stepping away from tax functions or simplified tax computations for certain socioeconomic core groups and instead implements the German tax and transfer system in a very detailed microsimulation model. This allows to consider not only the pure income tax tariff structure but also to assess complete tax load on labor on the employee's side stemming from income tax and employees' social security contributions. Given that the actual tax load in the end of the day is influenced by many more peculiarities of the tax and benefit system than just the income tax function, a more complete measure of household's tax load is developed. As tax rates are endogenous, simulated counterfactual tax rates a household would have faced had it not adapted its behavior to the reforms undertaken in that period, are constructed based on the microsimulation model. Individuals' relevant incomes are aged a year ahead using exogenous macroeconomic inflation indicators and the tax legislation in place that year is applied to the resulting hypothetical tax base. Estimation in first differences furthermore purges fixed effects.

Estimation results do not confirm the right-to-manage model developed by Lockwood and Manning (1993) and Holmlund and Kolm (1995a). The main implications of

the model that the average and marginal tax rates act in opposite directions yet of the same magnitude for employer payroll tax and employee side tax load is not supported by the data. The unambiguous prediction of the wage-decreasing effects of marginal payroll and the marginal overall tax load on the employee side in right-to-manage models in general is supported though. There is evidence for shifting of average payroll tax on consumer wages but on the brink of conventional significance levels. As the results are based on the overall tax load on the employee side all relevant tax loads are captured as opposed to the typical approach in the literature tackling income tax and social security contributions either on the employee or the employer side thus risking to neglect information important for unbiased estimation.

Along the wage distribution the result on the marginal overall tax load on the employee side is heterogeneous. A negative effect prevails in the bottom of the wage distribution and positive effects in the upper part. This evidence is suggestive of the prevalence of different wage setting regimes in different parts of the labor market. The lower part of the wage distribution is typically considered as the target audience and member base of unions; the wage-reducing effect of progressivity detected empirically is in line with the commensurate theories of imperfect labor markets. The upper part of the wage distribution that is associated with a great share of employees bargaining on a one-to-one basis with the respective employer over wages; empirically marginal tax rates do not exert a uniform effect across the work force.

These results caution against broad-brush policy recommendations proposing to cut or increase marginal taxes with the goal of promoting employment. Even provided that there is no adjustment in employment itself in response to such reform, the heterogeneous effects found along the wage distribution in this study pose a true challenge to the design of a well-targeted policy. Considering in addition that the tax load on employees is in part assessed on the household level and in part on the individual level makes the challenge to engineer marginal tax rates even more demanding. A point not raised here that further complicates any simple policy recommendations relates to the tax-benefit-link; the valuation of future benefits tied to taxes may be stronger for some kinds of taxes and more relevant to some employees depending on their level of wage and other income.

4.8 Appendix

4.8.1 Derivations in the wage bargaining model

The representative firm produces with a Cobb-Douglas production function, $Q_i = zN_i^{\alpha}$, where z is a productivity parameter, Q_i stands for output and N_i for employment. The firm sells at price p_i on the product market with monopolistic competition, $Q_i = (\frac{p_i}{p})^{-\varepsilon_d}$, given demand elasticity $\varepsilon_d > 1$. It cannot influence the aggregate price index p, such that

$$p_i = (zN_i^{\alpha})^{-\frac{1}{\varepsilon_d}} p$$

The firm maximizes its real profits $\Pi_i = \frac{p_i}{p} Q_i = (zN_i^{\alpha})^{1-\frac{1}{\varepsilon_d}} - \frac{W_i^p}{p} N_i$ given it has to pay producer wage W_i^p,

$$\begin{aligned}
\frac{\partial \Pi_i}{\partial N_i} &= \left(1 - \frac{1}{\varepsilon_d}\right) (zN_i^{\alpha})^{-\frac{1}{\varepsilon_d}} \alpha z N_i^{\alpha-1} - \frac{W_i^p}{p} \\
\frac{W_i^p}{p_i} &= \left(1 - \frac{1}{\varepsilon_d}\right) \alpha z N_i^{\alpha-1} \\
N_i &= \left(\frac{W_i^p}{p_i} \left[\alpha z \left(1 - \frac{1}{\varepsilon_d}\right) \right]^{-1} \right)^{\frac{1}{\alpha-1}}, \qquad (4.5)
\end{aligned}$$

Rewriting the firm's labor demand in terms of the real producer wage and eliminating the firms own price $p_i = (zN_i^{\alpha})^{-\frac{1}{\varepsilon_d}} p$ yields

$$\begin{aligned}
N_i^{\alpha-1} &= \frac{W_i^p}{\left(zN_i^{\alpha}\right)^{-\frac{1}{\varepsilon_d}} p} \left[\alpha z \left(1 - \frac{1}{\varepsilon_d}\right) \right]^{-1} \\
N_i &= \left\{ \frac{W_i^p}{p} \left[\frac{\alpha (\varepsilon_d - 1)}{\varepsilon_d} z \right]^{-1} z^{\frac{1}{\varepsilon_d}} \right\}^{\frac{\varepsilon_d}{\varepsilon_d(\alpha-1)-\alpha}} \\
N_i &= \left\{ \frac{W_i^p}{p} \left[\alpha' z \right]^{-1} z^{\frac{1}{\varepsilon_d}} \right\}^{-\frac{1}{1-\alpha'}},
\end{aligned}$$

where $\alpha' = \alpha\left(\varepsilon_d - 1\right)\varepsilon_d{}^{-1}$ and $\alpha' < 1$ and provided that the profit maximization problem is well-behaved (see Manning (1990, p. 152)). The elasticity of employment with regard to the real producer wage finally evaluates to $\varepsilon_N = -\frac{1}{1-\alpha'} < 0$.

Setting $c = \left[\alpha' z\right]^{-1} z^{\frac{1}{\varepsilon_d}}$ and substituting labor demand in the real profit function yields

$$\begin{aligned}
\Pi_i =& \left(z N_i^{\alpha}\right)^{1-\frac{1}{\varepsilon_d}} - \frac{W_i^p}{p} N_i \\
=& z^{\frac{\varepsilon_d - 1}{\varepsilon_d}} c^{-\frac{\alpha'}{1-\alpha'}} \frac{W_i^{p\,-\frac{\alpha'}{1-\alpha'}}}{p} - c^{-\frac{1}{1-\alpha'}} \frac{W_i^{p\,-\frac{\alpha'}{1-\alpha'}}}{p} \\
=& \frac{W_i^{p\,-\frac{\alpha'}{1-\alpha'}}}{p} \left\{ z^{\frac{\varepsilon_d - 1}{\varepsilon_d}} c^{-\frac{\alpha'}{1-\alpha'}} - c^{-\frac{1}{1-\alpha'}} \right\}
\end{aligned}$$

such that the elasticity of profits with regard to the real producer wage equals $\varepsilon_\pi = -\frac{\alpha'}{1-\alpha'} < 0$.

In the bargain between the firm and the union the negotiated wage W_i maximizes the Nash product

$$\Psi = \lambda ln\left(\Gamma_i - \underline{\Gamma}\right) + \left(1-\lambda\right) ln\left(\Pi_i - \underline{\Pi}\right).$$

The first order condition evaluates to

$$\begin{aligned}
\Psi_W =& \lambda \frac{\Gamma_W}{\Gamma_i - \underline{\Gamma}} + \left(1-\lambda\right) \frac{\Pi_W}{\Pi_i - \underline{\Pi}} = 0 \\
\Psi_W =& \lambda \frac{1}{\Gamma_i - \underline{\Gamma}} \left\{ \frac{\partial \Gamma}{\partial N} \frac{\partial N}{\partial W^p} \frac{\partial W^p}{\partial W} + \frac{\partial \Gamma}{\partial W^c} \frac{\partial W^c}{\partial W} \right\} + \left(1-\lambda\right) \frac{1}{\Pi_i - \underline{\Pi}} \left\{ \frac{\partial \Pi}{\partial W^p} \frac{\partial W^p}{\partial W} \right\} = 0.
\end{aligned}$$

While the union does not maximize directly over employment, employment makes part of its utility function and is indirectly affected through the negotiated wage. If the union weighs the consumer wage with the level of employment fixed by the employer, the derivative of union utility with regard to the negotiated wage results in two terms; for one in the direct effect of the wage on union utility, for another indirectly through the effect of wages on employment (also see Cahuc and Zylberberg (2004, p. 394)). An

exception to this is a union with seniority preferences that only values the level of the consumer wage.

Imposing symmetry ($W_i = W$), multiplying both sides with W, expanding with $\frac{\Gamma}{\Gamma}$ and $\frac{\Pi}{\Pi}$, and the first, second and third term with $\frac{W^p}{W^p}$ and $\frac{N}{N}$, with $\frac{W^c}{W^c}$, and with $\frac{W^p}{W^p}$ respectively and rearranging yields

$$\begin{aligned}
\Psi_W =& \lambda \frac{\Gamma}{\Gamma - \underline{\Gamma}} \left\{ \frac{\partial \Gamma}{\partial N} \frac{N}{\Gamma} \frac{\partial N}{\partial W^p} \frac{W^p}{N} \frac{\partial W^p}{\partial W} \frac{W}{W^p} + \frac{\partial \Gamma}{\partial W^c} \frac{W^c}{\Gamma} \frac{\partial W^c}{\partial W} \frac{W}{W^c} \right\} \\
& + (1-\lambda) \frac{\Pi}{\Pi - \underline{\Pi}} \left\{ \frac{\partial \Pi}{\partial W^p} \frac{W^p}{\Pi} \frac{\partial W^p}{\partial W} \frac{W}{W^p} \right\} = 0 \\
\Psi_W =& \lambda \frac{\Gamma}{\Gamma - \underline{\Gamma}} \left\{ \theta_N \varepsilon_N \left(\frac{1 + E'(W)}{1 + E(W)/W} \right) + \theta_{W^c} \left(\frac{1 - H'(W)}{1 - H(W)/W} \right) \right\} \\
& + (1-\lambda) \frac{\Pi}{\Pi - \underline{\Pi}} \varepsilon_\pi \left(\frac{1 + E'(W)}{1 + E(W)/W} \right) = 0 \\
& \lambda \frac{\Gamma}{\Gamma - \underline{\Gamma}} \left\{ \theta_N \varepsilon_N \nu_E^{-1} + \theta_{W^c} \nu_H \right\} + (1-\lambda) \frac{\Pi}{\Pi - \underline{\Pi}} \left\{ \varepsilon_\pi \nu_E^{-1} \right\} = 0
\end{aligned}$$

Note that the elasticity of employment and profits with regard to the real producer wage are constant at $\varepsilon_N = -\frac{1}{1-\alpha'}$ and $\varepsilon_\pi = -\frac{\alpha'}{(1-\alpha')}$. The consumption wage and employment elasticity of the union's utility equal $\theta_{W^c} = \frac{\partial \Gamma}{\partial W^c} \frac{W^c}{\Gamma} = \frac{(W^c)^\sigma}{(W^c)^\sigma / \sigma - \Gamma_0}$ and $\theta_N = \gamma$. Setting the fall-back pay-offs to zero ($\underline{\Gamma} = \underline{\Pi} = 0$), assuming isoelastic utility, rearranging and substituting yields

$$\begin{aligned}
\frac{(W^c)^\delta}{(W^c)^\delta / \delta - \Gamma_0} &= \frac{1}{\lambda \nu_H} \left\{ -\lambda \theta_N \varepsilon_N \nu_E^{-1} - (1-\lambda) \varepsilon_\pi \nu_E^{-1} \right\} \\
&= -\frac{[\lambda \gamma \varepsilon_N + (1-\lambda) \varepsilon_\pi]}{\lambda \nu},
\end{aligned}$$

where $\nu = \nu_H \nu_E$ and finally,

$$\begin{aligned}
(W^c)^\delta &= -\frac{[\lambda\gamma\varepsilon_N + (1-\lambda)\varepsilon_\pi]}{\lambda\nu}\left\{(W^c)^\delta/\delta - \Gamma_0\right\} \\
&= \frac{\lambda\nu\delta}{\lambda\nu\delta + \lambda\gamma\varepsilon_N + (1-\lambda)\varepsilon_\pi} \times \frac{[\lambda\gamma\varepsilon_N + (1-\lambda)\varepsilon_\pi]}{\lambda\nu} \times \Gamma_0 \\
&= \left[\frac{\lambda\nu\delta + [\lambda\gamma\varepsilon_N + (1-\lambda)\varepsilon_\pi]}{[\lambda\gamma\varepsilon_N + (1-\lambda)\varepsilon_\pi]\,\delta}\right]^{-1}\Gamma_0 \\
&= \left[\frac{1}{\delta} + \frac{\lambda\nu}{[\lambda\gamma\varepsilon_N + (1-\lambda)\varepsilon_\pi]}\right]^{-1}\Gamma_0 \\
&= \left[\frac{1}{\delta} - \nu\kappa\right]^{-1}\Gamma_0,
\end{aligned}$$

where $\kappa = -\lambda\left[\lambda\gamma\varepsilon_N + (1-\lambda)\varepsilon_\pi\right]^{-1}$.

With worker's outside option equal to $\Gamma_0 = [1-\psi(u)]\,(1/\delta)\,(W^c)^\delta + \psi(u)(1/\delta')B^{\delta'}$:

$$\begin{aligned}
(W^c)^\delta &= \left[\frac{1}{\delta} - \nu\kappa\right]^{-1} \times \left\{[1-\psi(u)]\,\frac{1}{\delta}\,(W^c)^\delta + \psi(u)\frac{1}{\delta'}B^{\delta'}\right\} \\
&= B^{\delta'} \times \left\{\psi(u)\frac{1}{\delta'}\left[\frac{1}{\delta} - \nu\kappa\right]^{-1}\frac{\delta}{\delta - \left[\frac{1}{\delta} - \nu\kappa\right]^{-1}[1-\psi(u)]}\right\} \\
&= B^{\delta'} \times \left\{\frac{\delta\psi(u)}{\delta'\left[\frac{1}{\delta} - \nu\kappa\right]\delta - \delta'[1-\psi(u)]}\right\} \\
&= B^{\delta'}\left[\frac{\delta'}{\delta} - \frac{\delta'\nu\kappa}{\psi(u)}\right]^{-1},
\end{aligned}$$

or without state specific utility $\delta' = \delta$:

$$= B^{\delta}\left[1 - \frac{\delta\nu\kappa}{\psi(u)}\right]^{-1}.$$

4.8.2 First stage estimation results for the baseline 2SLS specification, column (5) in Table 4.3

	Instrumented variables[1]							
	Specification (4) in Table 4.3:				Specification (6) in Table 4.3:			
	ln(1+(E(W)/W))	ln(1+E'(W))	ln(1-H(W)/W)	ln(1-H'(W))	ln(1+(E(W)/W))	ln(1+E'(W))	ln(1-H(W)/W)	ln(1-H'(W))
$\ln(1+(E(W)/W)^{sc})$	-0.137	0.123	-0.303	-0.733	-0.130	0.135	-0.109	-0.354
	(0.035)	(0.071)	(0.057)	(0.311)	(0.034)	(0.071)	(0.034)	(0.208)
$\ln(1+E'(W)^{sc})$	-0.010	-0.332	-0.010	0.211	-0.007	-0.338	-0.022	-0.032
	(0.013)	(0.031)	(0.024)	(0.120)	(0.013)	(0.029)	(0.013)	(0.058)
$\ln(1-(H(W)/W)^{sc})$	-0.005	-0.010	-0.258	-0.052	-0.009	-0.011	-0.272	-0.072
	(0.001)	(0.005)	(0.017)	(0.058)	(0.002)	(0.006)	(0.018)	(0.064)
$\ln(1-H'(W)^{sc})$	-0.001	0.003	0.002	-0.215	-0.002	0.002	0.003	-0.204
	(0.000)	(0.002)	(0.003)	(0.064)	(0.001)	(0.002)	(0.003)	(0.073)
ln(Real UE assistance)	-0.001	-0.009	-0.029	-0.017	-0.001	-0.009	-0.024	-0.026
	(0.000)	(0.001)	(0.002)	(0.004)	(0.000)	(0.001)	(0.001)	(0.003)
ln(Regional unemployment rate)	-0.001	-0.000	0.001	0.006	-0.001	-0.000	0.001	0.002
	(0.001)	(0.003)	(0.008)	(0.013)	(0.001)	(0.003)	(0.006)	(0.011)
ln(Degree of organization)	0.000	-0.000	0.001	-0.002	0.000	-0.000	0.001	-0.002
	(0.000)	(0.001)	(0.001)	(0.004)	(0.000)	(0.001)	(0.001)	(0.002)
2003	0.003	0.005	-0.010	-0.017	0.003	0.005	-0.005	-0.005
	(0.000)	(0.001)	(0.001)	(0.002)	(0.000)	(0.001)	(0.001)	(0.002)
2004	0.009	0.012	0.011	-0.009	0.009	0.012	0.018	0.013
	(0.000)	(0.001)	(0.002)	(0.003)	(0.000)	(0.001)	(0.002)	(0.002)
2005	0.010	0.011	-0.000	-0.005	0.010	0.011	0.015	0.018
	(0.000)	(0.001)	(0.003)	(0.004)	(0.000)	(0.001)	(0.002)	(0.004)
2006	0.011	0.012	-0.012	-0.020	0.011	0.013	0.012	0.014
	(0.000)	(0.001)	(0.002)	(0.004)	(0.000)	(0.001)	(0.002)	(0.004)
2007	0.003	0.004	0.001	0.001	0.003	0.004	0.007	0.010
	(0.000)	(0.001)	(0.002)	(0.003)	(0.000)	(0.001)	(0.001)	(0.002)
Constant	-0.001	-0.003	-0.002	0.006	-0.001	-0.003	-0.001	0.002
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
Relevance of instruments:								
Partial R^2 Shea	0.051	0.089	0.071	0.043	0.047	0.120	0.073	0.041
Angrist-Pischke first-stage χ^2 test statistic	18.937	89.945	218.854	10.864	18.338	122.618	210.335	8.019
... p-value in $\chi^2_{(1)}$-distribution	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.006

[1] "*sc* "refers to the simulated counterfactual values for the respective tax rates.
Notes: Standard errors clustered on industry level are reported in parentheses. Estimates are based on first-differenced data. Partial R^2 Shea is calculated as proposed by Shea (1997); Godfrey (1999). The related test for the relevance of the instrument variable, the Angrist-Pischke first-stage χ^2 test statistic, is based on the methodology proposed by Angrist and Pischke (2009, p. 217-218).
Source: Own calculations based on GSOEP 2001 through 2008.

Chapter 5

Conclusion

5.1 Main results and policy implications

The results presented in this thesis clearly show that labor market and tax policies play an important role for wage outcomes. The analyses also point out that the effects many times have a different impact or additional impacts than initially devised. Most likely some of these were originally not on policy makers' minds when designing the laws. Not only the loads, also the benefits of a policy maybe shifted towards economic agents that were originally not addressed by the policy. The dimensions of labor market regulation and tax policy examined in this thesis underline that actual incidence is not as easy to grasp than statutory incidence. If we are finally interested in policy making geared towards the economic incidence of institutions and not their statutory declarations, a close inspection (ex ante and ex post) of the schemes at work or planned is necessary. In this spirit, the thesis at hand sheds light on the actual incidence in three dimensions of public policy and labor market regulation.

In Chapter 2 I show that the incidence of minimum wages was mainly in East Germany. The positive wage increasing effects of the minimum wage introduction are large for the group of employee previously earning below the introduced lower wage limit. But the wage threshold set for West Germany was not binding. This thwarted what most people (including policy makers) would state as the initial motivation for a minimum wage introduction; raising the wages of those in the bottom of the wage ladder.

The policy raised wages particularly for employees not covered by collective agreements in East Germany, the group most bound by the minimum wage. It reduced wage inequality in the bottom of the distribution. But other groups of employees also benefitted from wage increases that were not at the centre of the policy. Employees paid according to some kind of wage agreement and situated in the middle of the wage distribution saw a significant wage increase despite not being bound by the minimum wage. Unions, possibly insider dominated or following the median voter scheme, constitute the employer's counterpart in the minimum wage setting process and bargain over a minimum wage not directly relevant for most of their members. Together with a preference for maintaining the wage hierarchy, this can explain the spillover of minimum wages to parts of the wage distribution not bound by the minimum wage; unions ensured that the relative wages of their members compared to their non-bound colleagues remained constant. While the analysis presented here does not delineate the exact mechanisms for minimum wage spillovers, empirical results clearly give indication of minimum wage effects going beyond impacts on those directly addressed by the policy. The results therefore call for caution as the institutional design in place points towards a greater impact than possibly intended.

The corporate income tax is hardly ever debated with regard to its implications for wage and employment outcomes in the public. The study presented in 3 clearly shows that the economic incidence on labor is sizable and should not be neglected. Debates on the corporate tax load considering only the burden on firms clearly miss out on essential features of the corporate tax. Two channels through which a change in corporate taxes affect the wage bill are identified. The "wage bargaining effect" captures that the rents the union and the firm can negotiate over, are greater when the corporate tax is decreased. The "user cost of capital effect" refers to changes in the price of capital due to a corporate tax reform that triggers a change in input factors. In sum this amounts to a two-fold impact on employment; profit maximizing firms retain the right to set employment after the wage rate has been agreed upon and will react to a higher bargained wage with a reduction in labor demand. This downward adjustment of the labor force is aggravated by the lower user cost of capital that leads firms to substitute labor with capital. The "wage bargaining effect" and the "user cost of capital effect" thus exert a diametrically opposed impact on the wage bill.

The empirical results support this reasoning. In the long run and when considering both channels of adjustment a € 1 decrease of corporate tax revenues carries over to a € 0.47 increase in the wage bill. Neglecting the employment correction to the wage bill leads to over-shifting of the tax burden, the familiar result in the literature so far. This result points out how important it is quantitatively, to develop a more comprehensive measure of the economic incidence of the corporate tax load. Moreover, it empirically supports the claim that the corporate tax is not only affecting firms but should also be debated in the dimensions of labor market outcomes.

The debate about the role of public finance solutions for labor market outcomes has ebbed away in the 2000s while empirical research on the elasticity of taxable income has been on the rise since and most recently again turned back on the question how the structure of taxation affects wages. Chapter 4 picks up on the effect of taxes on labor in Germany during the 2000s. Based on a wage bargaining model the predicted effects of average and marginal tax rates are assessed.

Marginal overall and payroll tax rates act wage-reducing as predicted by wage-bargaining models. While the average tax load on the employee has no significant influence on consumer wages, the effect of average employer payroll taxes on consumer wages is negative but not consistently significant. The strong form of the theory claiming that the type of tax is irrelevant and that the net-of-tax and retention rate have exactly opposing effects, is not supported. Allowing for differential effects of marginal tax rates along the wage distribution shows effect heterogeneity. The wage-decreasing effects in the lower part of the wage distribution are complemented by wage-increasing effects in the upper part of the distribution. This can suggestively be interpreted as the wage-bargaining model being more relevant for the lower paid and the better paid agreeing on a one-to-one basis with their employer on wages.

These results reject policies too simplistic with regard to the influence of tax rates on wages and potentially employment. In fact, the differential impacts found recommend a cautious approach to tax policy, particularly with regard to alterations in marginal tax rates provided the countervailing direction of effects on wages. The heterogeneity of effects in significance and direction across different groups of employees indicate an uneven incidence of tax policy across society.

5.2 Further research

Several interesting directions for further research that are beyond the reach of this thesis, appear worth investigating to attain a deeper understanding of the effects of minimum wage policy and the tax (and transfer) system on the labor market.

While policy makers in Germany seem to have made up their minds about introducing minimum wages for good in all parts of the economy, the specific design of the emerging reform is yet to be settled. Ex post policy evaluation as presented here and conducted for all other German sectors with minimum wage legislation to date (see IAB et al. (2011); IAW Tübingen (2011c,a,b)) provide an understanding of what happened in the sectors already covered. Extending the conclusions drawn and stretching the limited external validity of these studies to underpin an indiscriminate expansion of minimum wage legislation to the economy as a whole is a dangerous thing to do. Ex ante policy simulations that include features of labor demand as in Müller and Steiner (2010b) constitute a more suitable instrument to complement policy makers' information set. Analyses in this vein also allow to look at effects beyond a specific sector and gauge the overall macro effects. Given the contradicting opinions whether to set a national minimum wage or alternatively a schedule of minimum wages across industries, an extension of these scenarios to the different institutional minimum wage designs debated now would be a very valuable contribution.

Beyond the overall effects a critical assessment of other less considered effects of minimum wages merit attention. The question whether the minimum wages so far introduced led to an increase in (fake) self-employment has been voiced (IAB et al., 2011, p. 258). Quantitatively this question is yet without answer. The critical question whether undifferentiated minimum wages have an effect on young people's decisions is another unexplored route of research that has received wide attention in other countries (see i.a. Neumark and Wascher (1996); Zavodny (2000) for the US). Particularly in the German context it is highly relevant whether minimum wages discourage young people to take up vocational training. Anecdotal evidence suggests that the incentives for young people to enter vocational training and for employers to offer apprenticeship opportunities possibly worsened due to the minimum wage legislation for painters and glazers (IAW Tübingen, 2011b, p. 236).

In Chapter 3 the role of user cost of capital was highlighted for the assessment of corporate tax incidence. A change in corporate tax rates has consequences for the relative price of input factors and thus substitution effects may arise. Clearly there is good reason to believe that overall an even more intricate relationship between capital and employees of different qualification levels is important. If i.e. the capital-skill complementarity hypothesis holds, meaning that skilled labor is more complementary with capital than unskilled labor (see Griliches (1969)), a differential impact across wages should be observed and skilled labor should bear comparatively more of the tax load than unskilled labor. Felix (2007) takes empirically a first step in this direction. She finds no differentiation of the tax load across skill levels when estimating the impact of corporate tax rates on samples split along the skill dimension yet the specification used models neither capital nor employment explicitly. A lot of work is still needed in order to refine and test empirically which channels are at work when corporate income tax is passed onto employees and which mechanism contributes to what extent in the shifting of corporate taxes onto labor.

The effect of different types of tax rates and their structure on consumer wages was examined in Chapter 4. The study takes a look at the effects of different taxes on net-of-tax wages and touched on the role of the overall tax. For analyzing the potential mechanisms linking the tax system to employment clearly a broader approach to the topic has to be taken, particularly in view of a balanced public budget. Recently Pirttilä and Selin (2011) outlined for the case of Sweden the different institutions at work (including value-added tax) and point out that labor market policies such as low-wage subsidies and EITC should be considered. A closer look is particularly necessary for those with very low incomes. Immervoll (2007) coin the term of the "participation tax rate". In the scope of a microsimulation model it captures the gap between the overall tax rate when working as opposed to when not working and indicates whether an individual actually has a financial gain from working. Such measure therefore allows to go beyond the analysis of tax effects on hours and wage rates of the employed and sheds light on the role of the tax and transfer system for the unemployed or respectively very low paid. As these groups of society are often at the centre of policy making and a non-negligible part of public financing goes towards them a better understanding of the mechanisms at work is essential.

Moving away from the classic approach taken here several other channels of adjustments seem worth to be analyzed; recent studies studies focusing on the marginal rate alone have emphasized the role of work effort in hourly wage rate responses to changes in the net-of-marginal-tax rate (see i.e. Blomquist and Selin (2008)). Ljunge and Raganz (2008) stress that while hours of work may not be very responsive to tax rates, the margin through which individuals adjust labor earnings in response to tax rate changes is through work effort.

Some empirical evidence points towards a greater elasticity of the intensive margin with regard to marginal tax changes for female employees (Klevmarken, 2000). Modelling women's decision to work half-time or full-time in the scope of a switching regression model with marginal tax rates appears another promising avenue for future research. There seems to be political consensus on the need to further increase female labor market participation. Tax splitting for couples in contrast gives rise to a particularly severe reduction of income for married women in Germany and a joint empirical analysis of hours worked and wage rates therefore is very much relevant for policy makers.

Executive summary

This thesis centers on the question who actually bears the loads and the benefits of a policy. While the statutory incidence of policy measures can easily be looked up in the commensurate laws the economic incidence maybe a different matter altogether. The thesis at hand sheds light on the incidence of three dimensions of tax and labor market policy; the effect of a minimum wage on the wage structure and hours of work, the shifting of the corporate tax burden onto labor, and the impact of taxes and their structure on wages.

Germany introduced its first minimum wage in 1997 for blue-collar workers in subsectors of the construction industry. With linked employer-employee data a considerable bite of the minimum wage in East Germany shows, but none in West Germany. Differences-in-differences-in-differences estimations confirm that the MW introduction led to a significant average wage growth in East Germany. The effect is clearly significant for those employees not paid according to a collective agreement while the overall effect for those paid according to the wage bargaining contract is on the brink of significance. Unconditional quantile regressions show that spillovers along the wage distribution are highest in the bottom of the wage distribution and level out along the distribution. In the region of the distribution where the union's median voter is most possibly located spillovers also are detected for those under collective agreement. While in West Germany there is no evidence for wage effects at the mean, spillovers to the middle of the distribution show. On the intensive margin of labor supply no effects of the MW are found.

The question who actually bears the corporate tax burden is assessed in the scope of a unique pseudo-panel data set drawing from the complete records of corporate taxation and employee compensation. Recent empirical evidence emphasized the role of bar-

gaining over economic rents for determination of incidence on wages. Besides the role of bargaining this study also addresses another channel of adjustment of the wage bill through changes in labor demand triggered by the altered user cost of capital. Variation of firm-specific average corporate tax rates across firms and time brought about by corporate tax reforms is used to verify the different channels through which the corporate tax may be shifted onto wages. To account for endogeneity of tax rates, the counterfactual corporate tax rate is used that would have arisen in case that firms had not adjusted their behavior in response to the tax, computed by means of a detailed microsimulation model (BizTax). Estimation in first differences furthermore purges fixed effects. Incidence results show that a € 1 cut in corporate tax leads to a € 0.47 increase in the wage bill when employment adjustments due to changes in the user cost of capital are accounted for.

Finally I consider the impact of income and payroll taxation and the tax benefit system as a whole on consumer wages. A wage bargaining model with taxes as developed by Lockwood and Manning (1993) and Holmlund and Kolm (1995a) predicts in its strict form that marginal and average tax rates should have the reverse effects and progressivity of employer payroll and employee side tax loads (income tax and social security contributions) should act in the same direction. To consider these predictions empirically the German tax and transfer system is implemented in a very detailed microsimulation model (STSM) to consider the household context and the institutional rules relevant for assessing the tax rates levied on an employee's wages. This allows to consider not only the influence of the income tax alone but also employees' social security contributions as a more comprehensive measure of tax load faced by individuals. Endogenous tax rates are instrumented by their simulated counterfactuals encountered by the employee had he not adapted its behavior to the reforms undertaken in that period using STSM. Estimations in first differences show that the direction of effects predicted for marginal tax rates by the bargaining model are shared by the empirical evidence. But the model's predictions do not hold in its strict form; it is not only the non-proportionality of the tax system that matters, but also do different taxes have different effects. While marginal tax rates decrease consumer wages, some effect heterogeneity of marginal overall tax load on employees is detected along the wage distribution. A stronger negative effect of

marginal taxes is detected in the bottom of the wage distribution and positive effects are found in the upper part.

Zusammenfassung

Im Fokus dieser Dissertation steht die Frage, wer letztlich die Lasten und den Nutzen einer Politik trägt. Während die gesetzlich festgelegte Inzidenz einzelner Politikmaßnahmen im jeweiligen Gesetzestext abgelesen werden kann, mag die ökonomische Inzidenz sich gänzlich anders darstellen. Die vorliegende Arbeit beschäftigt sich mit drei Dimensionen der ökonomischen Inzidenz in Steuer- und Arbeitsmarktpolitik: zum Einen mit den Effekten des Mindestlohns auf die Lohnstruktur und die Arbeitszeit, zum Zweiten mit der Überwälzung der Körperschaftssteuer auf die Löhne, und schließlich mit den Auswirkungen von Steuern und ihrer Struktur auf Löhne.

Der erste Mindestlohn in Deutschland wurde 1997 für gewerbliche Arbeiter im Bauhauptgewerbe eingeführt. Auf Basis eines verbundenen Arbeitnehmer-Arbeitgeber-Datensatzes zeigt sich, dass die Eingriffsintensität des Mindestlohns in Ostdeutschland sehr stark war, wohingegen kaum ein Eingriff in Westdeutschland stattfand. Differenzen-in-Differenzen-in-Differenzen-Schätzungen bestätigen, dass die Mindestlohneinführung zu signifikantem Lohnwachstum in Ostdeutschland geführt hat. Dieser Effekt ist eindeutig für diejenigen betroffenen Arbeitnehmer, die nicht gemäß eines Tarifvertrags bezahlt werden. Für diejenigen, die einem Tarifvertrag unterliegen, ist der Effekt nicht eindeutig signifikant. Unbedingte Quantilsregressionen zeigen, dass es zu Spillover-Effekten kam, die am höchsten am unteren Ende der Lohnverteilung ausfielen und zur Mitte der Verteilung hin abflachen. Diese bleiben bestehen für Beschäftigte, die nach Tarifvertrag bezahlt werden und sich in der Mitte der Verteilung befinden, einer Region in der Verteilung, in der der typische Medianwähler der Gewerkschaft angesiedelt ist. Solche Spillover-Effekte lassen sich auch in Westdeutschland beobachten. Der Mindstlohn hatte keine signifikanten Effekte auf die Arbeitsstunden.

Die Frage, wer letztlich die Last der Körperschaftssteuer trägt wird auf Basis eines Pseudo-Panels betrachtet, dass auf den Gesamterhebungen der Körperschaftssteuerstatistik und der sozialversicherungspflichtig Beschäftigten beruht. Neuere empirische Evidenz weist den Gewerkschaftsverhandlungen über ökonomische Renten eine Rolle bei der Überwälzung der Körperschafssteuer auf die Löhne zu. Neben dem Einfluß der Lohnverhandlungen beschäftigt sich diese Studie auch mit einem weiteren Anpassungsmechanismus der Lohnsumme, nämlich der angepassten Arbeitsnachfrage in Folge der veränderten Kapitalnutzungskosten. Reformen der Körperschaftssteuer führen zu Variation der firmenspezifischen Körperschaftssteuer zwischen Unternehmen und über die Zeit. Diese Variation wird genutzt, um die verschiedenen Anpassungsmechanismen durch die die Körperschaftssteuer auf die Löhne umgewälzt werden kann, zu untersuchen. Die Endogenität der Steuersätze wird berücksichtigt, indem die kontrafaktischen Steuersätze, die zustande gekommen wären, wenn die Unternehmen ihr Verhalten nicht aufgrund der Steuerreform angepasst hätten, als Instrumentvariablen mit Hilfe des Mikrosimulationsmodells BizTax kalkuliert werden. Schätzung in ersten Differenzen nimmt zudem den Einfluß der fixen Effekt heraus. Inzidenzergebnisse zeigen, dass eine Reduzierung der Körperschaftssteuer um € 1 zu einer € 0.47 höheren Lohnsumme führt, wenn Beschäftigungsanpassungen aufgrund der veränderten Kapitalnutzungskosten einfließen.

Schließlich betrachte ich den Einfluß von Einkommenssteuer und Sozialversicherungsbeiträgen auf Konsumentenlöhne. Gemäß dem Gewerkschaftsmodell mit Steuern wie es von Lockwood and Manning (1993) und Holmlund and Kolm (1995a) entwickelt wurde, sollten durchschnittliche und Grenzsteuersätze genau entgegengesetzte Effekte auf die Löhne haben und die Progressivität der Sozialversicherung auf der Arbeitgeberseite und die der Abgabelast auf der Arbeitnehmerseite (Einkommenssteuer sowie Sozialversicherung auf Seiten der Arbeitnehmer) sollte genau in diesselbe Richtung wirken. Um diese Vorhersagen empirisch einzuordnen, wird das deutsche Steuer-Transfer-System mit Hilfe des Mikrosimulationsmodells STSM implementiert, um alle relevanten Faktoren, wie z.B. den Haushaltskontext, die auf die Steuerlast wirken und damit letztendlich auf Konsumentenlöhne wirkt, zu berücksichtigen. Auf diese Weise kann nicht nur der Einfluß der Einkommenssteuer, sondern auch in einem breiteren Ansatz die gesamte Last, die die Löhne betrifft, betrachtet werden. Die endogenen Steu-

ersätze werden instrumentiert mit ihren im STSM simulierten kontrafaktischen Werten, die zustande gekommen wären, wenn der Beschäftigte sein Verhalten in Reaktion auf die verschiedenen Reformen nicht angepasst hätte. Schätzungen in ersten Differenzen zeigen, dass zumindest die Vorhersage, dass höhere Grenzsteuersätze Löhne senken, empirisch bestätigt werden kann. Allerdings sprechen die Ergebnisse gegen eine strikte Interpretation des Modells. Die Nicht-Proportionalität des Steuersystems alleine ist keine ausreichende Beschreibung des Effekts der durchschnittlichen vs. der marginalen Sätze, sondern sie sollten einzeln betrachtet werden. Auch zeigen sich Unterschiede zwischen der Wirkung der Einkommenssteuer und der Last auf Seiten der Arbeitnehmer. Während die Grenzsteuersätze die Konsumentenlöhne reduzieren, zeigt sich, dass der Effekt der gesamten Grenzsteuerlast auf Arbeitnehmerseite nicht gleichbleibend ist entlang der Lohnverteilung. Während er den Konsumentenlohn am unteren Ende der Verteilung reduziert, wirkt er positiv am oberen Ende.

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