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Business Taxation and Wages: Redistribution and Asymmetric Effects*

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Abstract

Empirical evidence on the degree of business-tax shifting is rare. It remains open to which extent the tax burden is shifted, whether there are differences for tax increases and decreases, or whether there exists some treatment heterogeneity. Using a large administrative panel data set, we exploit the regional variation of the German business-income taxation and find that 65% to at most 93% is shifted to labour through real wage adjustments. We find that business taxation increases wage inequality significantly. Workers in a weak labour-market position bear the highest part of business taxation. The incidence effect of tax reliefs is significantly higher than that of tax increases. Therefore, reducing business taxes might, surprisingly, effectively reduce inequality.

Keywords: tax incidence · profit taxation · wages · inequality · asymmetric effects

JEL codes: H22 · H25 · H32 · J31 · J38

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1 Introduction

Corporate income taxation is very popular among many voters and policy makers because alleged wealthy capital owners are supposed to bear the burden. Firms may have the possibility to shift the tax burden through different channels, however. They may pass the burden to consumers through higher prices, to capital by lowering dividends and the rate of return, or to workers in form of lower (increases of) wages and, indirectly, via lay-offs. Competition reduces the scope for price increases and hence for shifting the tax burden to consumers. The markedly lower mobility of labour *vis-à-vis* capital suggests that in an open economy with liberalized capital markets labour may bear a large part of the tax burden levied by business taxation (Harberger 2008). The public perception concerning corporate taxes may root, ironically, in the potentially faulty perception of the corporate interests themselves that it is a tax on them, which reinforced the public idea that reducing, or even abolishing, corporate taxes would redistribute toward "the rich" (Stiglitz 2002).

According to Fuchs et al. (1998: 1398), economists from the leading forty U.S. research universities estimate the burden of corporate income taxation borne by capital – excluding the 25% of most extreme opinions at the tails – to range from 20% to 65%. This wide range of estimates may be explained by the limited empirical evidence on the incidence of corporate income taxation. Recent empirical work on the issue focus on the relationship between corporate income taxation and wages using country- or firm-level data. Using different data sets and methodologies, the majority concludes that labour bears a substantial portion of the burden from corporate income taxation (Arulampalam et al. 2012; aus dem Moore 2014; aus dem Moore et al. 2014; Desai et al. 2007; Felix 2007; Gentry 2007; Hassett and Mathur 2006). The estimated elasticities of wages with respect to corporate income taxation range from about -0.09, restricting the analysis to the direct incidence, to about -0.9, measuring the whole general equilibrium effect. This range basically confirms the results found by simulations of general equilibrium (GE) models, assuming an open economy, in which capital is more mobile than labour (Harberger 1995, 2008; Randolph 2006; Gravelle and Smetters 2006). Recent contributions emphasize that multinationals can avoid taxes by, e.g., profit shifting, and that multi-regional companies may avoid local taxes within a nation in a similar way. Hence, such firms may have less an incentive to shift the tax to labour. Using cross-country data and focusing especially on multinationals and international aspects, Clausing (2013) finds no evidence for a negative effect of corporate taxation on labour. Riedel (2011) also uses data of multinationals and provides evidence that under a tax regime of separate accounting corporate taxation raises domestic but decreases foreign workers' wages. Analysing local U.S. state corporate taxes, Suárez Serrato and Zidar (2016) find that labour bears only 30% to 35% of the burden.

A potential limitation of these studies is that the authors could not observe individual wages, but were forced to calculate average wages as the wage sum per employee at the country- or firm-level, or to use wage indices. Only a few empirical studies estimate the impact of business taxes on wages using individual-level data (Bauer et al. 2012; Dwenger et al. 2013; Felix and Hines 2009; Fuest et al. 2015; Liu and Altshuler 2013). This type of studies also provide evidence of a negative wage effect of corporate income taxation. While Dwenger et al. (2013) find that only 19% to 29% of an additional unit tax burden is borne by labour, the other studies state an average share of at least 50%, in line with the result of Arulampalam et al. (2012) based on firm data.

This paper contributes to the existing literature in several respects. We use an extensive administrative individual panel-data set to estimate Mincer-type wage equations and address not only the issue of tax shifting in general but also the issues of redistributional effects as well as asymmetric effects of tax in- and decreases. Compared to alternative survey data, administrative data do not involve problems such as non-response, interviewer effects or survey bias, and provide significant more observations. Furthermore, the specific case of Germany allows to analyse the issue within one country, because there is a substantial part of the corporate income tax that is levied heterogeneously at the regional level. Hence, compared to cross-country studies, the implicit assumptions of common production technologies, equal market conditions, and a common trend are more reasonable. Combining the regional variation in taxation with the variation of wages at the individual level, we believe to improve the identification of the causal impact of business income taxes on wages.

Our empirical results suggest that labour bears a significant burden of corporate income taxes. Our estimates suggest an incidence effect of 65% to at most 93%. We provide first evidence that changes of business income taxes have asymmetric wage effects: the degree of shifting of tax reliefs is significantly higher than that of tax increases. We argue that this may root in downward-rigid wages (e.g., Goette et al. 2007) and reciprocal behaviour. We also show that corporate income taxation causes a significant increase in wage inequality, because the tax-induced wage effects differ significantly across different groups of employees. Employees in a weak labour market position, such as unskilled, workers with unemployment experience, and those with high tenure, suffer most from tax shifting. The incidence effect also differs markedly between industries. This result adds to Liu and Altshuler (2013), who have shown that different degrees of market competition involve different incidence effects in different industries. That is, business taxation involves significant redistributional effects – a fact typically ignored in the context of business tax reforms.

The paper proceeds as follows: in Section 2, we further discuss the literature on the incidence of business income taxation, and in Section 3, we outline the relevant aspects of the business tax system as well as the wage determination process in Germany. In Section 4, we provide our theory and derive our hypotheses. In Section 5, we describe the data and explain our identification strategy. The estimation results are presented in Section 6. In Section 7, we discuss several robustness checks. In Section 8, we deduce the incidence effect and determine how much percent of a local tax burden is shifted to labour. We conclude in Section 9.

2 Relation to the Literature

In the seminal Harberger (1962) model, business taxes are designed as a partial factor tax on capital,[1] so that there is a substitution effect, which reduces the return on capital relative to wages, and an output effect, which may reinforce or counteract the substitution effect, depending on whether the taxed sector is capital- or labour-intensive. In such short-term two-sector closed-economy models, the tax is not shifted and capital bears the complete burden of business taxes (see also Mieszkowski 1967; Ballentine and Eris 1975). Incorporating the labour-leisure decision, a partial burden can also be borne by labour (Shoven and Whalley 1972). In dynamic models, in contrast, it is the factor labour that bears the complete burden (Diamond 1970; Feldstein 1974a,b; Friedlaender and Vandendorpe 1978; Ballentine 1978).[2] The reason is that the dynamic closed-economy model predicts that the tax cannot be shifted in the short run, because the marginal product of capital is fixed, but that in the long run, the reduced net interest rate reduces capital intensity and thus wages, until the original level of net interest is re-established (Sinn 1987).[3] Given the closed-economy assumption of these studies appeared to be inadequate in modern times, Harberger assumed an open economy with free capital mobility, where labour may bear close to the full burden of corporate income taxes (e.g., Harberger 1995,

[1] Given the non-neutrality of corporate income taxation in most countries, a corporate income tax is a tax on the use of capital or on the returns to equity, which increases the cost of finance (see also Sinn 1987: 298).

[2] See also the early work of Cosciani (1958/59).

[3] Most of these studies, however, implicitly assume a uniform taxation of all kinds of capital income (i.e., retained and distributed profits as well as interest income), which is unlikely (Sinn 1987: 299).

2008),[4] because the after-tax rates of the return to capital equalize at the world capital market. Changes in national corporate taxation will only increase the national gross-of-tax rate of return to capital and result in capital flight. Consequently, the wage rate decreases. But Gravelle and Hungerford (2011) as well as Gravelle (2013) emphasize that capital mobility is still incomplete, that there is international tax avoidance, and that, at least for the U.S., the closed-economy assumption might be more accurate due to international tax policy links. Hence, they conclude that, in fact, in an open global economy, capital bears the major burden, too. Therefore, based on the theoretical literature, it is difficult to draw final conclusions.

Most of this literature also assumes that wages are determined at fully competitive labour markets. Arulampalam et al. (2012) and Riedel (2011), in contrast, emphasize that wages are often determined by negotiations between firms and unions. Arulampalam et al. (2012) provide evidence that a profit tax is shifted to labour as the tax reduces the rent of firms that is distributed between the firm and the workers based on the respective bargaining power. We extend this theory on the link of wage negotiations and corporate taxation to heterogeneous labour, and analyse redistributional consequences as well as asymmetrical effects of tax in- and decreases.

There are two papers that also use individual micro data to address corporate income tax shifting in Germany (Dwenger et al. 2013; Fuest et al. 2015). Both also account for wage bargaining and exploit the variation of the German regional profit tax. Both papers, however, do not account for asymmetric effects of tax in- and decreases, as we do. In contrast to us, Dwenger et al. (2013) do also not account for distributional effects of corporate taxation. While Fuest et al. (2015) also provide some analysis of worker heterogeneity, they mainly focus the effects of firm and labour-market institutions heterogeneity. None of both do analyse the effect of corporate taxation on inequality, as we do. In contrast to Fuest et al. (2015) – and in line with Dwenger et al. (2013) – we assume that the decisive tax variation for wage bargaining in Germany is not at the level of municipalities but at a more aggregated level, because unions in most cases do not bargain wages in a particular municipality and specific firm, but for a local labour market region and complete industry. Hence, we exploit the variation of the average tax rate at the county level, which ought to be closer to the relevant tax indicator in real world.

[4] Many restrictive assumptions have been relaxed in later papers (Fullerton and Metcalf 2002).

3 Business Taxation and Wage Determination

3.1 The German Corporate Income Taxation

The German corporate taxation is determined at two levels, the federal and the regional level. The tax regulation is strongly centralized at the federal level, however. Therefore, not only the tax rate as well as the tax base of the federal business tax, labelled "Körperschaftsteuer" (KSt)[5], are identical across regions, but also the tax base regulation for the regional business taxation. Only the tax rate of the regional business tax is determined by the regional governments, which generates spatial variation of the business tax burden.

The federal tax rate levied on profits of corporations, denoted by τ_{KSt}, is flat. Starting in 1991, an additional "solidarity surcharge" σ has been added to the federal tax burden as a source to finance the German re-unification, resulting in the overall federal tax rate being *de facto* given by $(1+\sigma)\cdot\tau_{\text{KSt}}$. For the regional level, the tax law only constitutes a basic tax rate m (labelled "Messzahl"). Municipalities are entitled to deviate from this base rate by applying a regional collection rate c_r (labelled "Hebesatz"), resulting in a nominal regional tax rate of $\tau_r(c_r) := m \cdot c_r$, that is, they can collect the basic rate m ($c_r = 1$) or more or less than it. The regional tax liability itself is deductible from the regional tax base as cost. Hence, the statutory regional tax rate is effectively given by $\tau_r^{\text{eff}}(c_r) = \tau_r(c_r)\cdot[1+\tau_r(c_r)]^{-1}$. This regional tax liability is again deductible from the respective federal tax base. Thus, the final federal tax liability per Euro of tax base is calculated as $(1+\sigma)\cdot\tau_{\text{KSt}}\cdot\left[1-\tau_r^{\text{eff}}(c_r)\right]$, so that the effective federal-cum-regional tax rate of corporations is determined by

$$\tau^{\text{eff}}(c_r) = \tau_{\text{KSt}}\cdot(1+\sigma) + [1-\tau_{\text{KSt}}\cdot(1+\sigma)]\cdot\tau_r^{\text{eff}}(c_r), \tag{1}$$

with $\partial\tau^{\text{eff}}/\partial c_r = [1-\tau_{\text{KSt}}(1+\sigma)]\cdot m/(1+mc_r)^2 > 0$. The actual tax parameters are summarized in Table 1. The average collection rate c_r in our sample is 3.81 (the period covered by our data is 1995 to 2004). It increased from 3.71 in 1995 to a maximum of 3.86 in 2003. The average total effective corporate income tax rate, τ^{eff}, is 48.5%; due to major business tax reforms it decreased from 56.0% in 1997 to 37.8% in 2004. Due to the different levels of c_r, the regional effective business-tax rate τ_r^{eff} varies from 8.3% to 20.5% in our sample (see Table 2), which represents a significant variation at the local level.

[5]We describe the German business taxation of the residual non-incorporated firms in the Appendix. They are taxed very similar. Although there are many of these by number, they are typically small and do not cover a bigger part of the German employment.

The effective tax burden is further affected by regulations concerning the tax base, such as depreciation rules, which involves accelerated depreciation in Germany. All these reductions and depreciation rules are implemented on the federal level and are relevant for all firms alike. The tax base is divided by particular criteria (often by the wage sum) among jurisdictions, if there are cross-jurisdiction multi-plant or cross-border firms. Hence, a focus on a more aggregated regional level of tax rate is adequate for analysing the effect of business taxation on wages determined by bargaining.

3.2 The Wage Determination Process in Germany

An analysis of the degree to which firms are able to shift their tax burden towards their workers through wage adjustments requires a thorough understanding of the wage determination process in Germany. It is important to differentiate between negotiated wages, usually bargained between the trade unions and employer associations, and the actual wages paid by a firm. Concerning negotiated wages, bargaining can take place basically in two different ways: (i) at the industry level for a particular region or (ii) between trade unions and (usually large nation-wide located) single firms. These wages are only binding as a kind of minimum wage for all firms organized in the respective employer associations and need to be paid to all employees of these firms. Note that in Germany this holds irrespective of whether the workers are trade union members.

The number of employees covered by wage agreements decreased from more than 70% in 1995 to 61% in 2004 in West Germany, and from 56% in 1996 to 41% in 2004 in East Germany (Ellguth and Kohaut 2005: 399). In 2004, only 7% (12%) of the employees were covered by firm level agreements in West-Germany (East-Germany). There are significant differences in the coverage between industries, ranging from 34% in the sector of business related services to 85% in the public sector in 2004 (Ellguth and Kohaut 2005). Distinguishing, more aggregated, processing industries (manufacturing), construction, and services, the highest coverage is found in construction (about 80% in the West and 48% in East), followed by processing trade (about 65% and 35%), and services (about 50% and 34%) having the lowest coverage (Kohaut and Ellguth 2008). About half of the workers that were not covered by any union wage negotiation (32% in West, 48% in East Germany), declared that their wages nonetheless are geared by wage agreements. Hence, the wages of about 84% of the employees in West Germany and 76% in East Germany were determined – directly or indirectly – by wage negotiations (see also Dustmann et al. 2009), predominantly by negotiations at a regional industry level. The wage agreements determine wage adjustments for each single year and cover very different employee groups.

One critique on the dominating industry collective wage agreements is that these cannot account for the special situation of single firms, e.g., for the specific local tax rate at the level of a municipality. The same holds for company wage agreements, because these companies are located across municipalities in a county or beyond. Hence, it is important to emphasize that only the average tax rate of the labour market region (county) is accounted for, irrespective of the specific change in a single municipality. There are, moreover, considerable differences in effective wages due to voluntary extra wage payments of the companies. The difference between the growth rates of the negotiated wages and the effective wage levels, the 'wage drift,' was negative between 1995 and 2004, the period covered by our empirical analysis: from 1995 to 1999, union wages rose by 2.8%, while effective wages rose only by 2.6%; from 2000 to 2004, the respective numbers were 2.0% versus 1.7% (German Council of Economic Experts 1996–2005). Thus, there exists a negative correlation between growth of union wages and growth of effective wages. This suggests that firms that voluntarily pay extra payments can use these to partly circumvent union wage agreements.

4 Theory

Given a distortionary business taxation, profit taxes are like a tax on capital. In an open economy with free capital mobility, capital is redeployed to abroad, so that the marginal product of labour, and thus presumably the wages, decrease. If wages are rather determined by negotiations by unions and federations of enterprises, profit taxes increase the cost of capital and reduce the rent that is distributed between firms and employees according to their respective bargaining power. Hence, profit taxes reduce the wage, too (Arulampalam et al. 2012). The shifting of the burden of corporate income taxes to wages in an open economy with free capital mobility and free trade may be reinforced by the structure of the national labour market. Given small (uncompensated) labour supply elasticities of men (Laisney et al. 1992; Zabel 1997; Evers et al. 2008), shifting the tax burden partly to labour through wage changes is less costly than shifting it to the relatively more mobile capital, i.e., while shifting the tax burden to investors would cause capital flight, wage-cuts will not cause a dramatic decrease in labour supply. Following the theory of optimal taxation, the least mobile good or factor should be taxed highest (Gordon 1986). If firms follow the same logic when shifting tax burdens the less mobile factor labour bears more of the tax burden than capital.

4.1 Distributional Effects of Business Taxation

Extending this logic to the case with heterogeneous employee groups, firms shift the tax burden to the least mobile workers: these groups will face the highest level of wage effects due to corporate income taxation. Therefore, we argue that if labour bears some of the burden of corporate income taxation, the share of the burden borne by a particular group of workers is likely to be disproportional – and tax policies will result in unintended effects on the income distribution. Moreover, allowing for different groups of workers, the burden of corporate income taxes borne by labour may not only vary across these groups due to a different degree of mobility but due to a different bargaining position, too. For example, globalization and skilled-biased technological change has increased the demand for skilled workers, resulting in increased income inequality and polarization (e.g., Autor et al. 2006; Card et al. 1999; Dustmann et al. 2009), especially in OECD countries (Dreher and Gaston 2008).

In the appendix we provide a formal model of wage bargaining with heterogeneous employee groups n. We find that the degree of incidence rises with the respective bargaining power fraction of group n, labelled γ_n, and the group specific capital intensity K/L_n, because the increased capital cost are distributed to less employees per capital unit. *Ceteris paribus*, (i) employees in capital intensive sectors face stronger negative tax incidence effects, because an increase in capital cost affects total cost to a higher extent; (ii) employee groups representing a bigger group in the industry will face smaller negative tax incidence, because the group-specific rent per employee is lower, and thus the shifting fraction, too; and (iii) the tax incidence is increasing with the bargaining power of the union (γ) and the weight the trade union attaches to employee group n (a_n), which follows from a resulting higher group-specific rent due to higher γ_n.

All elements that determine the tax incidence for wages, i.e., group-specific capital intensity (stock of capital K divided by group-specific employment L_n), group-specific bargaining power γ_n, and the effect of the local tax rate on the user cost of capital w_K ($\partial w_K / \partial \tau^{\text{eff}}$), may differ between sectors and, hence, involve different group-specific incidence effects. Industry-specific effects of the local tax rate on the user cost of capital w_K root especially in the fact that the regional tax base comprises some additional elements of taxation of cost: half of all long-term interest payments on debt are part of the tax base. That is, the tax base of the regional tax is wider if there is long-term debt. While in some industries long-term debt is more or less insignificant, in others it is widely used. The specific effect of the local tax, therefore, is industry-specific due to different degrees of long-term debt financing of capital.[6] Overall, profit taxation, therefore, may cause changes in the distribution of wages in favour of employees in less capital intensive industries. As a matter of pure numbers, the wage distribution is affected to the disadvantage of smaller employee groups, given a fixed capital stock K, because, *ceteris paribus*, they are predicted to suffer relatively more from profit tax shifting. Referring to part (iii) the question arises, which groups are mainly in the focus of trade unions. Chamberlain (1994) provides evidence that union membership has a larger effect on the lower quantiles of the conditional distribution of U.S. wages. Fitzenberger et al. (1998) find for Germany that union membership decreases for employees with above-average wages. Moreover, they find that the degree of membership is concave with respect to age (with a maximum at age 50), is significantly lower for persons with a university degree or white-collar status, and differs significantly between industries. Therefore, we assume that unions push the interests of unskilled and blue-collar employees, which have lower wages, weaker power in personal bargaining with the employers, and typically are relatively more organized in unions. Additionally, employees in midlife ought to be accounted for by unions. If this is the case, unskilled and blue-collar employees and employees in the midlife would face the strongest incidence effects. Combining the estimates of Fitzenberger et al. (1998) on the net rate of organization for 46 sectors, the industry with the highest union membership among employed in our data is 'transport, storage, and communication' (about 49%), and those with the lowest are the service sectors (below 15%, respectively) and construction (about 17%).

In practice, wage agreements cover a single wage growth rate and additional one-time payments for all workers alike (beside many additional aspects). This also suggests that there are always heterogeneous wage effects in percent, and that low-wage workers are affected most by tax shifting. As outlined in Section 3.2, there has also been a negative wage drift in the analysed period, that is, companies reacted to increased bargained wages by cutting wages paid above the negotiated wage. When firms decide on employee-group specific wages, after wage bargaining, they have to take group specific labour supply elasticities and the level of competition at the respective labour market into account. The competition for high-skilled workers together with the evidence that they are more mobile than low-skilled workers may limit the possibility of firms to impart the burden of corporate taxes to skilled workers. A similar argument may be put forward concerning the role of job tenure. To the extent that workers with higher job tenure accumulated more firm-specific human capital and hence have more bargaining power, firms may be reluctant to incriminate these workers with the costs of business taxation. However, if the wage

[6] Note that firms within an industry have very similar financial structure (and firm structure in general).

of employees with very high tenure is determined predominantly by firm-specific human capital, this capital is less productive in other firms. Moreover, high tenure workers may have higher mobility costs, which in turn increase their risk of suffering from tax incidence. Overall, these arguments suggest that the burden of business income taxes that is borne by labour may fall predominantly on young and unskilled workers as well as potentially on workers with high tenure.

4.2 Asymmetric Effects of Business Taxation

Another interesting issue is whether the profit tax incidence is symmetric, that is, whether tax increases have the same effect in absolute terms as tax reliefs. We argue that the analysis must attend to the role of wage rigidities. There is ample evidence that labour markets are characterized by downward nominal and real wage rigidities (e.g., Altonji and Devereux 2000; Bauer et al. 2007; Behr and Pötter 2010; Dickens et al. 2007; Fehr and Goette 2005; Goette et al. 2007; Heckel et al. 2008; Knoppik and Beissinger 2003). This suggests that tax reliefs, that are expected to involve wage increases, should generate a higher tax incidence effect than profit-tax increases, which require reductions in the wages. The reasons for these rigidities can be manifold. For firms covered by wage bargaining, the negotiated wage acts as a minimum wage. Wage reduction, thus, are only possible in the typically small bracket of voluntarily paid higher wage levels; stronger reductions got to be adjourned until the next bargaining. Unions, in turn, try to prevent wage cuts (Holden 1994, 2003), while supporting wage rises. Then, significant real wage cuts are only possible by inflation or productivity growth. In low-inflation economies as Germany, however, the inflation effect on real wages is of limited power. Firms may also hesitate to cut wages, as wage cuts may increase the probability of losing productive workers. There is evidence that nominal wage cuts are considered as unfair and that workers react to wage cuts by a reduction in their effort, e.g., due to reciprocal behaviour (Kahneman et al. 1986; Fehr and Gächtner 2000; Elsby 2009). Especially in low-inflation economies money illusion seems to be important. Shafir et al. (1997), for instance, report that nominal wage cuts by 2% at zero inflation are considered by workers to be by far more unfair as a nominal wage increase by 2% at a rate of inflation of 4%. Following efficiency-wage models, wage increases, in contrast, can be used to motivate workers, as they respond to rising wages by exerting higher effort due to reciprocity (e.g., Stiglitz 1976; Akerlof and Yellen 1990). These considerations suggest that tax policies that induce an incentive to cut wages ought to have smaller wage effects than policies that induce wage increases.

5 Data and Identification Strategy

5.1 The Used Panel Data

We use individual microdata obtained from the regional files of the IAB Employment Sample (IABS), provided by the Research Data Center of the Institute for Employment Research (IAB). The IABS is a representative 2% random sample of the *Employment Statistics Register*, an administrative panel data set of the employment history of all individuals employed in Germany who worked between 1975 and 2004 in an employment relationship covered by social security. In 1995, for example, the *Employment Statistics Register* contained the labour market history of almost 80% of all employed persons in West Germany, and more than 86% of all employed persons in East Germany.[7] The advantage of this administrative data set is a higher number of observations and a more precise information on wages compared to survey data (Dustmann et al. 2009).

The IABS provides information on the average gross daily wages in a year.[8] We analyse real gross daily wages, by deflating wages using the German Consumer Price Index (CPI) in year 2000 prices (Federal Statistical Office 2004 and 2006). The wage in the IABS is censored from above due to a ceiling for the social security contributions, which may bias our estimation results.[9] In our sample, between 8% and 12% of the observed wages are right-censored per year. To deal with this problem, we rely on the imputation method proposed by Gartner (2005), a well-established standard procedure for analysing the wage data of the IAB Employment Sample (Baumgarten 2013; Dustmann et al. 2009; Guertzgen 2009).[10] Further information provided by the data comprises the employees' year of birth,

[7]The employee history is based on the integrated notification procedure for health insurance, the statutory pension scheme, and unemployment insurance. At the beginning and end of any employment spell employers are obliged to notify the social security agencies. This spell information is exact to the day. For spells spanning more than one calendar year an annual notification is compulsory and provides an update on the employment characteristics of the employee. See Bender et al. (2000) for a detailed description.

[8]It covers daily net pay plus personal taxes and employee's contributions to the social security system, but not the employer's contributions.

[9]In Germany, employees are only obliged to pay social security contributions up to a certain gross wage – the contribution ceiling. In the data, the wage of employees who earn wages above the ceiling is set to the level of the ceiling, which causes a truncated wage distribution. Dropping these individuals would change the skill distribution, because individuals with wages above the ceiling are predominantly high skilled (Bauer et al. 2007).

[10]In a first step, a tobit model with a standard wage equation is estimated. In a second step, the right-censored observations are replaced by a random draw from a truncated normal distribution with the contribution ceiling defined as lower limit and the two moments of the distribution obtained from the preceding tobit regression. In the literature, there are also more complicated imputation techniques (Büttner and Rässler 2008; Gartner and Rässler 2005). As Dustmann et al. (2009: 878) show, more sophisticated techniques do not improve the imputation significantly, though.

sex, education, labour market region of the working place,[11] occupational status, and industry. The education variable is corrected via a procedure proposed by Fitzenberger et al. (2006), because the original IABS suffers from missing values and inconsistencies with the reporting rule.[12] The wage information suffers from some additional problems (Bauer et al. 2007). Prior to 1984, one-time and extra payments were not reflected in the recorded wage information. Furthermore, Hunt (2001) showed that the determination of wages in Germany changed markedly in the years after the German reunification in 1990. Because of these problems, we restrict our empirical analysis to the period from 1995 to 2004.

Similar to other developed countries, the wage elasticity of labour supply in Germany is much higher for (married) women if compared to (married) men (Bargain et al. 2012; Steiner and Wrohlich 2004). Therefore, we exclude female workers from the empirical analysis, because our estimates would suffer from sample-selection bias, otherwise. For similar reasons, we also exclude part-time workers, homeworkers and trainees. In all these cases, real wage reductions would cause some of these individuals either to leave the labour market or to change from full-time to half-time jobs, respectively reduce their hours worked, so that the observed effect on the average daily wage is biased and misleading.[13] Furthermore, we excluded all workers employed in mining as well as those working in the farming, forestry, or energy sector. Companies in the forestry and farming sector are very often exempted from the local business tax. In the mining and energy sectors, in turn, there are special regulations for the local business tax, so that the local effect of changing tax rates is open.[14] Civil servants and self-employed are not covered by the data, because they are not part of the formal social security system. Finally, we restrict our analysis to workers not younger than 16 and not older than 62 years, because workers older than 62 are often already in special (pre-)retirement systems, so that the wage reported in the data may be misleading. The remaining sample covers 2,030,058 person-year-observations of 353,158 individuals.

The local collection rates at the county level are taken from the Real-Tax Statistics of the

[11]We thus do not have the problem of measurement error in cases in which people live in one region and work in another, as in other studies, where it was only possible to observe the place of residence.

[12]We apply procedure IP1.

[13]We also estimated the basic regressions for female workers alone and found no clear evidence that women's wages are influenced by regional tax assessment. The majority of working females is covered by wage negotiations of unions, where the sex is irrelevant, which puts some doubt on this finding. The gender-wage-gap literature suggests that women rather suffer more from tax shifting due to belonging to lower wage brackets. Hence, our finding is presumably driven by the selection bias.

[14]For instance, if in a municipality there are only facilities for transferring energy, the energy company is tax-exempted. If a mining company only has in-ground facilities the company is tax-exempted, too.

Federal Statistical Office (Federal Statistical Office 1999-2010). Further regional data are collected from diverse sources, detailed below. The regional variables have been merged with our sample of individuals using the regional identifiers available in the data. Descriptive statistics of all variables are reported in Table 2. Due to missing values for some regressors, the number of observations for the basic regressions further dropped to 1,758,020. The average collection rate, weighted by the number of employees we observe in the respective region in our sample, is 3.81 (Table 2). Figure A.1 in the Appendix shows the distribution of the average collection rates of the German counties for the period covered by our data. It illustrates that there is substantial regional variation of collection rates. On average, the biggest cities, such as Berlin, Hamburg and Munich, and industrial regions, such as the Ruhr area, tend to have higher collection rates, which is in line with the theory that larger jurisdictions earn tax premia due to market power and market size (Hoyt 1992; Buettner 2001). The bottom of Table 2 also provides descriptive statistics on changes in the collection rates in our sample. The variation of the collection rate between the counties and over time appears to be sufficient to credibly identify the effect of wages due to the local tax rate. The standard deviation of the collection rate per year is close to 50 percentage points. On average, about 62% of the observations involve a changing effective regional tax burden. Decreases of the collection rate are markedly less common than tax increases: on average, about 20% of the observations involve a decreasing collection rate, versus 42% for tax increases. This suggests that there is also sufficient variation to investigate asymmetric tax incidence. In addition to the variation of collection rates we obtain some variation through inter-regional job switchers (movers): on average, more than 7% of the observations involve a change of the region of the working place. In these cases, we obtain variation in the collection rate even if the collection rate in both counties is unchanged, given they differ in levels.

5.2 Econometric Model and Identification Strategy

To investigate the effect of business income taxation on wages, we estimate different specifications of the following augmented Mincerian wage equation (Mincer 1958):

$$\ln(w_{it}) = X_{it}\beta + \delta \ln(\tau_{rt}^{\text{eff}}(c_{rt})) + Z_{rt}\rho + S_j\gamma_S + R_r + T_t + \nu_i + o_k + N_l \cdot T_t + \epsilon_{it}, \tag{2}$$

where w_{it} refers to the real gross daily wage of employee i in year t. X_{it} is a matrix of socio-economic characteristics of individual i in year t, including age and age squared, three dummy variables describing the educational attainment of an individual[15] (no vocational training, *vocational training without secondary schooling*, secondary schooling degree with or without vocational training, and university degree), two dummy variables describing the occupational status of a worker (unskilled, *blue-collar*, and white-collar including master craftsmen), a variable indicating whether an individual changed establishments in period t, job tenure and job tenure squared, as well as the constant. Z_{rt} denotes a vector of regional characteristics of the region r where individual i works in year t, including the number of firms per employee to measure regional competition (Glaeser et al. 1992), the local unemployment rate as a control for the local business cycle and measure of the regional labour market position of employees[16], the log of value-added per employee as a measure of labour productivity, firm density (firms per m^2) as a measure of increasing labour productivity due to increasing returns generated by congestion and agglomeration effects (Ciccone and Hall 1996), and the number of employees.[17] S_j represents a vector of ten sector or industry dummies ($j = 1, \cdots, 10$) controlling for unobserved time-invariant industry effects.[18] R_r is a vector of regional, T_t a vector of year, ν_i a vector of individual, o_k a vector of occupation ($k = 1, \cdots, 129$), and $N_l \cdot T_t$ regional NUTS2-year fixed effects (with N_l representing l NUTS2 dummies, $l = 1, \cdots, 39$).[19] The NUTS2-year dummies allow to control for the regional business cycle and other unobserved regional-specific year fixed effects. The error term ϵ_{it} is assumed to satisfy the usual properties.

The main parameter of interest is δ, the elasticity of wages with respect to a change in the regional effective tax rate τ_{rt}^{eff}: $\delta \equiv \eta_{\tau_{rt}^{\text{eff}}}^{w} \equiv \frac{\partial w/w}{\partial \tau_{rt}^{\text{eff}}/\tau_{rt}^{\text{eff}}}$. Given that the tax rate at the federal level and the tax bases at the federal as well as regional level are determined solely at the federal level, such changes are controlled for by the year fixed effects and the NUTS2-year fixed effects.[20] An important identification issue is the level of variation of the tax rate

[15] In the following, the reference group is identified by italic font, respectively.

[16] Hirsch et al. (2013) empirically confirm the relevance of the local unemployment rate as direct measure of employers' wage-setting power within the underlying wage bargaining framework.

[17] The information on the size of local population stems from the official Regional Accounts (VGRdL 2010), the size of the counties from the Regional Data Base of the official statistical offices (`http://www.statistik-portal.de/`), and the local unemployment rate from the official statistics of the German Federal Employment Agency.

[18] We distinguish: basic goods and other consumption goods; *investment goods industry*; consumer goods industry; food, drinks and tobacco; construction industry; trade, distributive services; transport and communication industry; business related services; public, health, culture services; other services.

[19] NUTS represents the official Classification of Territorial Units for Statistics in the European Union. NUTS2 is the second administrative subdivision and represents in Germany the governmental region between states (NUTS1) and the counties (NUTS3). The NUTS2 governments are lower authorities of the states. In some states these lower authorities were abolished, so that NUTS2 is a regional aggregation level only.

[20] Given the regional tax liability is deductible within the federal tax, changes of the federal taxation affect the federal tax liability heterogeneously. The year fixed effects would only control for the average

used in the regression. The collection rates are determined by municipalities and the town-and-county units ("Kreisfreie Städte"). Given wage bargaining is, in most cases, an industry-specific negotiation at a regional level more aggregated than the municipality, the tax-burden variation accounted for is at this more aggregated level. Following Dwenger et al. (2013) – and in contrast to Fuest et al. (2015) – we thus use the average effective tax rate τ_{rt}^{eff} at the county level.[21] However, more than 44% of the employees in our data work in urban municipalities that represent the lowest jurisdiction with a single collection rate (town-and-county), where this difference does not exist.

As Arulampalam et al. (2012), we quantify the direct wage effect only. We estimate regression model (2) using different specifications. The NUTS2-year fixed effects control for time-variant local peculiarities.[22] The individual fixed effects also involve the time-invariant establishment-specific effect, as long as employees do not change establishments. This is the case for about 60% of the observed employees; 23% changed at most once. Controlling for regional fixed effects, we implicitly also control for average regional unobserved establishment heterogeneity. Consequently, Klein et al. (2013: footnote 18) found that the results of wage regressions including only individual fixed effects and those including individual and plant fixed effects are very similar. Controlling for time, region and individual fixed effects, the identification of our main parameter of interest δ comes either from counties where the average collection rate changed from one year to another, or from individuals who moved to a working place in another county or urban municipality with a different collection rate.

To learn who suffers most from business taxation due to pass-through, and about potential distributional effects, we additionally allow for heterogeneous incidence effects for heterogeneous groups of education, age, job tenure, industry, occupational status, and

effect, but the NUTS2-year fixed effects control for it at the disaggregated NUTS2 level. The heterogeneity roots in the different local levels of τ_{rt}^{eff}, that we control for. We also used the overall effective tax rate as a specific trend variable in certain specifications. This trend variable was dropped due to collinearity in all specifications once time fixed effects were included. This suggests that time dummies perfectly control for all tax regime changes at the federal level. Without year-specific effects the coefficient of this trend is, as expected, highly significantly negative.

[21]Fuest et al. (2015) argue that using the average tax rate at the county level is generating spurious variation, because the average collection rate of a county is changed whenever one single municipality within the county is changing its rate, though the plants of other municipalities in this county are not affected. However, wage bargaining takes place at a higher regional industry level or supra-regional firm level, so that exactly this average regional tax rate is decisive. Therefore, we argue that using the municipality tax rate or collection rate is spurious.

[22]We also estimated the equation excluding individual and regional fixed effects via OLS, for comparison, which delivers biased estimates of δ because of unobserved regional and individual characteristics that are correlated with both, the collection rate and wages. The OLS regression produces positive coefficients for δ. Once we control either for individual or regional fixed effects alone, the expected negative sign is observed, but the shifting elasticity is overestimated in absolute terms.

unemployment experience. For this purpose, we estimate the group specific effects in a fully interacted model, that is, each single regressor of model (2) is interacted with all group dummies. The advantage of this approach *vis-à-vis* interacting the dummies with the tax regressor only, is that we do not implicitly assume that all other regressors have equal effects for all distinguished groups alike. Thus, we prevent potentially biased group-specific estimates (e.g., Angrist and Pischke 2009).[23] Our theory further predicted that the incidence effect differs among different industries. Therefore, we also provide estimates by industry, to deduce the industry-specific wage elasticities.

To deepen and test our hypothesis of a redistributional effect of corporate income taxation, we then calculated four inequality indicators for the regional wage distribution at the county level, respectively: the Gini coefficient as well as the three generalized entropy class indicators $GE(a)$ with inequality aversion parameter $a = -1$, 0, and 1. The measures are explained in more detail in the Appendix D (for more details see, e.g., Cowell 2000). The Gini coefficient is most sensitive to differences at the middle of a distribution. The $GE(0)$ indicator is known as the mean logarithmic deviation and is sensitive at the middle of a distribution, too. The $GE(-1)$ indicator is sensitive at the bottom of the wage distribution, and the $GE(1)$ indicator, known as the Theil index, is sensitive at the top of the distribution. Therefore, the set of inequality measures allows to identify inequality effects of taxation at the bottom, the middle, and the top of the wage distribution, respectively. We thus estimate equation (2) replacing the dependent wage variable by the corresponding four wage inequality indicators of individuals i, respectively, and test whether the tax regressor has, as expected, a significant positive coefficient.

We finally test the hypothesis of asymmetric incidence effects of tax increases and reliefs by separating the development of the local effective business tax rate into tax cuts and tax increases via an interaction term. That is, we interact the local effective tax variable with an indicator variable for decreasing tax rates, $D(\text{neg})$. The dummy $D(\text{neg})$ is zero as long as the first difference of the tax rate is non-negative and unity otherwise. Hence the coefficient of the tax regressor measures the wage elasticity of tax increases and the coefficient of the interaction term the deviation from this effect in case of tax rate decreases. The crucial test is whether the coefficient of the interaction term is statistically different from zero. The elasticity for tax-rate decreases can be deduced via the Delta method as the coefficient of the tax-rate increases minus the coefficient of the interaction term.[24]

[23] Comparing our fully-interacted regressions with the usual regressions where only the coefficient of interest is interacted with the group dummies reveals that the estimates are indeed significantly different.

[24] Note that the interaction term is the product of the tax-rate decrease dummy and the effective tax rate. That is, the coefficient measures the effect of an increase of the tax rate by one unit, as usual. However, this increase in fact always involves a tax-rate decrease. Hence, the wage elasticity of a tax-rate

Our identification of the pass-through effect relies on the assumption of exogeneity of the tax regressor. There could be unobserved shocks to individual wages that are correlated with the tax regressor. Local business cycles may reduce wages and, simultaneously, increase the local tax rate to compensate for revenue losses. The literature on local tax mimicking due to tax competition (e.g., Wilson 1986; Zodrow and Mieszkowski 1986), benefit spillovers (e.g., Case et al. 1993), or yardstick competition (e.g., Besley and Case 1995) may also challenge exogeneity. While there exists empirical evidence for tax mimicking around the world, recent literature suggests that this may root in invalid instruments applying spatial lags IV approaches (Gibbons and Overman 2012; Baskaran 2014). Applying a difference-in-differences approach to a natural experiment Baskaran (2014) finds no evidence for local tax interdependence in Germany, and demonstrates that a lag of exogeneity of the typically used instruments within an IV spatial lags model may cause biased estimates. Exploiting other natural experiments, Lyytikäinen (2012) finds that municipalities in Finland do not interact in their tax decisions, and Isen (2014) that this is also the case for local governments in Ohio, applying a regression discontinuity approach. Additionally, recent tax reform literature suggests that the major driving forces of tax changes are variables positioned in the political sphere (instead of economic variables) (Castanheira et al. 2012). Foremny and Riedel (2014) find robust evidence that the local tax rate policies of municipalities in Germany are driven by the electoral cycle, and not by economic development. Yet unpublished papers suggest, nonetheless, that at least massive changes of the tax system in Germany may involve some significant regional tax-competition effects (von Schwerin and Büttner 2016), and that a key determinant of the interdependency is the level of economic integration of neighbour municipalities (Holzmann and von Schwerin 2015). However, we use a tax regressor measuring the average tax rate at the county level, instead of the specific at the municipal level, so that the issue of local tax competition is unlikely an issue. Moreover, we control for potential regional business-cycle effects by including the local unemployment rate, number of firms, employment, value-added, and control for unobserved year-specific regional effects by NUTS2-year fixed effects. Hence, as argued by Liu and Altshuler (2013), it is unlikely that individual wages are correlated with unobserved determinants of the tax rate at the county level.[25] Finally, we observe individual wages and restrict our data to groups where

decrease is the coefficient of the benchmark case (tax-rate increase) minus the coefficient of the interaction term.

[25]Investigating the determinants of municipal collection rates in Germany, Buettner (2001) did not find wages to determine the local tax rate in a spatial lag model. Additionally, the collection rate of a year is usually announced in the last months of the pre-year, when the development of the local economy is not yet realized. The payroll taxes are also fully centralized in Germany, and distributed via tax sharing. The local profit tax revenue is the most important tax source of municipalities, but taxes do not represent the

a sample selection bias due to unemployment transitions or labour hours adjustment is unlikely. That is, in contrast to average firm or country wages, our wage variable does not vary due to changing employment or full-time/part-time transitions, and is unlikely to vary due to the business cycle.[26]

6 Results

Our basic results on the wage elasticity with respect to the effective local tax rate are summarized in Table 3. From column (1) to (4) we stepwise extend the regression model. In column (1) we only control for individual characteristics and individual, industry, county, and year fixed effects. In column (2) we add regional covariates, in column (3) occupation fixed effects, and in column (4) NUTS2-year fixed effects. For all specifications, standard errors are clustered at the county level. In all models the wage elasticity with respect to the local effective corporate tax rate, δ, is statistically significant different from zero and negative, as expected. While adding the regional covariates halves the estimated coefficient for δ, controlling for occupation fixed effects does not change the estimate much. Controlling for NUTS2-year fixed effects, in contrast, significantly reduces the estimated wage elasticity to a value of -0.0286. This demonstrates the importance of controlling for regional annual developments.

Table 4, part I, shows the results of the group-wise fully interacted regressions. Our results suggest that education (part A) is not the major determinant for the size of shifting. Only for employees with vocational training without secondary schooling we find a (highly) statistically significant negative effect. In contrast, occupational status (part B) seems to be a major determinant of the size of shifting. There is a clear decreasing pattern from unskilled to white collar employees, that is, the unskilled face the highest burden, while we do not find a significant effect for white collar workers. Concerning tenure (part C) we find an interesting pattern. The coefficients decrease from 'no tenure' over '1 to below 5 years' to '5 to below 10 years,' but all of these coefficients are insignificant, that is, we do not find evidence for an effect. The only significant negative effect we find for employees with the highest level of tenure. The found elasticity is the highest for all distinguished characteristics in part I. As explained in Section 4, staying with a firm for a long time

most important source of finance. The profit tax displayed a share in the budget of the municipalities of only 15% (1997). Unconditional grants of the state ("Länder") and the federal government (16%), own charges (16%), and many other sources (together about 53%) are at least equally important (Buettner 2001: Table 1). Finally, about one-fifth of the local gross profit-tax revenue has to be passed on to the state and federal government ("Gewerbesteuerumlage").

[26] A lack of valid instruments made it impossible to produce valid IV estimates for comparison.

may weaken the job mobility due to accumulated firm-specific human capital and a life arranged with their job at the firm (own house, family etc.). Referring to age (part D), we only find a (highly) significant effect for employees in the middle of their working life, which is in line with the fact that union membership is highest in this working age. Finally, unemployment experience (part E) weakens the labour market position, so that corporate taxation is shifted to these workers.

We also find significant differences among industries (part II of Table 4). The results for specification (4) of Table 3 by industry sample splits reveal statistically significant negative elasticities only for four of the ten sectors: 'consumer goods,' 'food, drinks and tobacco,' 'construction,' as well as 'transportation and communication.' The strongest significant negative wage elasticity we find for the 'food, drinks, and tobacco' sector, and the sector 'trade and distributive services.' Theory offers very complex effect patterns to explain this heterogeneity. Based on our model, the incidence effect is high in sectors with high capital intensity, union coverage, union power, and rate of union membership among employees. Our empirical results additionally suggest that the specific employment structure in an industry is decisive: when there are more un- and low skilled workers the tax incidence is higher, for instance. Liu and Altshuler (2013) showed that the industry-specific market concentration increases the incidence effect. Finally, industries with many employees in multinationals and international competition may display lower to no (Clausing 2013) or even positive incidence effects (Riedel 2011). The highest incidence effects in the consumer goods, food, and trade sectors can be explained with a relatively high net rate of organization, high capital intensity, higher wage agreement coverage in manufacturing and trade, high union power, and, at least for the food and trade sectors, by many low skilled workers.

The heterogeneous effects suggest that business taxation may significantly affect wage inequality, and our results provide evidence for this hypothesis (Part A of Table 5). All inequality measures are positively affected by the effective local corporate tax rate, at least at a significance level of 5%. That is, corporate taxation increases inequality. While the effect on the Gini and GE(0) indices provide evidence for an effect at the middle of the wage distribution, the positive coefficient for GE(-1) provides evidence for an effect at the bottom of the wage distribution, and that for GE(1) for the top of the distribution. Hence, the wage distribution becomes more unequal due to corporate taxation throughout the entire wage distribution. The increasing trend of the coefficients from GE(1) over GE(0) to GE(-1) suggests that the effect may be regressive in terms of the wage: the strongest effect is at the bottom for low wages and decreases toward higher wages.

In Part B of Table 5, we report the results of our regression where we re-estimate model (4) of Table 3 allowing for asymmetric effects. We find evidence for our hypothesis that tax reliefs involve a higher degree of shifting: the coefficient of the interaction term for tax reliefs reveals that tax decreases involve an (in absolute terms) significantly higher tax elasticity of −0.0341, *vis-à-vis* an elasticity of −0.0332 for tax-rate increases. Applied to the mean real daily wage in our sample (€ 91.54) and an average effective local tax rate of 15.9%, our result suggests that an increase of the effective local tax rate by 1%-point to 16.9% reduced the annual real wage by about € 69, while a reduction to 14.9% increased it by about € 72.

7 Robustness Checks

We perform multiple robustness checks. First, it could be argued that our estimates may be biased downward if employees tend to evade the negative tax-induced wage effect by taking a new job in an unaffected region. Given labour mobility at the local level ought to be higher than at the national, this option is more plausible in our setting than in cross-country analyses. In contrast, employers may have the advantage to shift their tax burden much easier when a new labour contract is bargained for switchers. We account for this issue by estimating the specific effects for inter-county job switchers and stayers. The result can be found in part F of Table 4. It turns out that employees who change job from one county to another seem to be able to prevent any real wage loss due to corporate taxation via their mobility. While the 'stayers' face an average effect of about −0.0288, the job switchers' elasticity is not statistically different from zero. Obviously, job mobility is not sufficient to prevent the pass-through of business taxation to the workers in total, however.[27]

Similar to Klein et al. (2013), we also address the issue of a potentially remaining omitted-variable bias due to unobserved heterogeneity by extended fixed effects specifications. So far we do not account for heterogeneous annual industry developments that may affect wages. The year fixed effects control for the average effect over all sectors, but not for industry-specific effects. To improve identification we thus control for industry-year fixed effects, as a robustness check (model (1) of Table 6). Additionally, the specific personal characteristics of employees might cause a different wage level in different industries as well as in different regions, for instance, due to different traditions and conventions.

[27]Empirical studies on labour mobility emphasize that labour mobility in the European Union (EU), including Germany, is low and only about half of that in the U.S. (e.g., IZA 2008).

Schank et al. (2007), Andrews et al. (2008), Munch and Skaksen (2008), and Woodcock (2008) also discuss corresponding match-specific effects on wages, which can be a source of significant omitting-variable bias. In order to control for such unobservable effects we include individual-industry (model (2)) and individual-county fixed-effects (model (3)), which correspond to a complex full set of interaction terms between employee and industry dummies, respectively between employee and county dummies. Wages may further be affected by heterogeneous regional industry structures. We thus also included county-industry fixed effects, to control for different industry composition (model (4)). Finally, different occupational structures of firms might affect wages across regions to a different extent. Hence, we also included county-occupation fixed effects (model (5)). The results in Table 6 demonstrate that additionally controlling for industry-year (-0.0276), individual-industry (-0.0291), individual-county (-0.0308), county-industry (-0.0244), or county-occupation (-0.0268) fixed effects indeed produces some variation of the elasticity estimate. The elasticity ranges in an area from -0.0244 to -0.0308.

Given that our regressor of interest varies at the county level and the dependent variable at the individual level, this might cause a special within-group correlation and produce spurious regression (Kloek 1981; Moulton 1986: 385). Moulton (1990) shows that ignoring this intra-group correlation can generate estimated standard errors that are likely to be downward biased. Following Angrist and Pischke (2009: 319), the standard cluster adjustment developed by Liang and Zeger (1986), that generalizes the White (1980) correction of standard errors by allowing for clustering as well as for heteroskedasticity, solves the problem as long as the number of clusters is 'large enough.' With 343 labour market regions (counties) as clusters, and thus clearly more than the rule-of-thumb limit of about 42, the applied clustering method ought to address the issue well (Angrist and Pischke 2009; Donald and Lang 2007). As an alternative correction technique, however, we also used the two-step estimation procedure of Combes et al. (2008) as a robustness check. In a first step, only the regressors at the individual level are considered in the estimation procedure, together with an interaction term of the county and year dummies. In a second step, the estimated county-year-specific effects of the first stage are regressed on all aggregated region-specific variables, including the local effective tax rate (model (2-stage) in Table 6). The alternative two-stage estimator produces an elasticity of -0.0350, which suggests that we, so far, might have underestimated the effect a little bit.[28]

[28]We also included the tax regressor one period forwarded as well as one and two periods lagged, to deduce some dynamic effects due to anticipation or lagged effects. The tax regressor is neither significant in the preceding nor in the two succeeding periods, however (results not reported).

8 Tax-Rate Elasticity and Incidence Effect

We deduce estimations for the elasticity with respect to the total federal-cum-local corporate tax rate via the Delta method. Table 7 provides our estimations of the extrapolated wage elasticity with respect to the total effective corporate tax rate for our major results in Tables 3 and 6. Once controlling for the regional annual development (NUTS2-year fixed effects), our results for the wage elasticity referring the total effective corporate tax rate is ranging from -0.0743 to -0.0939; the two-stage estimator produces -0.1066. This is located in the (lower) area found by Arulampalam et al. (2012), who reported a range of -0.076 to -0.120.

The central incidence issue, however, is how much percent of the regional business tax is shifted to employees, respectively, how many cents of an extra €1 or \$1 tax burden are actually borne by labour. In Arulampalam et al. (2012), the data provide information on the respective tax payment of the firms, so that the incidence effect is a firm's wage sum per employee divided by the tax burden per employee multiplied with the estimated elasticity of the per-worker wage sum with respect to the per-worker tax payment. Given that we are estimating the elasticity of the exact individual gross wage with respect to the effective regional corporate tax rate, we have to modify this approach slightly. The *ceteris paribus* interpretation of our elasticity δ is $\frac{\partial w/w}{\partial \tau_r^{\text{eff}}/\tau_r^{\text{eff}}}$, so that:

$$\frac{\mathrm{d}w}{\mathrm{d}\tau_{rt}^{\text{eff}}} = \delta \cdot \frac{w}{\tau_r^{\text{eff}}} \tag{3}$$

Let L represent the sum of employees and W the total wage sum given by $w \cdot L$. And let T_r and B_r denote the tax payment respectively the tax base for the regional profit tax, so that $T_r = \tau_r^{\text{eff}} \cdot B_r$. If we additionally denote the tax burden per employee by $t_r = \tau_r^{\text{eff}} \cdot \frac{B_r}{L}$, we can rearrange (3) to

$$\frac{\mathrm{d}w}{\mathrm{d}t_r} = \delta \cdot \frac{W}{T_r} \tag{4}$$

which is similar to equation (3') in Arulampalam et al. (2012). Note that, in contrast to Arulampalam et al. (2012), $\frac{W}{T_r} = \frac{w}{t_r}$ is not wage per total corporate tax payment but wage per regional corporate tax payment. We use the county-specific regional corporate tax payments in our county data, which have the advantage that they cover all actual regional corporate tax payments, so that the data are representative for German firms. Since we are exploring the effect of the regional corporate tax on employees covered by social security, we deduce the average W and T_r weighted by the share of employees covered by social security over the counties. We obtain $W/T_r = w/t_r = 26.6$. Our measure of business tax incidence, labelled ι, thus is $\iota \equiv \frac{\mathrm{d}w}{\mathrm{d}t_r} = \delta \cdot \frac{W}{T_r} = \delta \cdot 26.6$. A complete shifting of the regional corporate tax to the employees via wage adjustments corresponds with an elasticity of $\delta = 1/26.6 = 0.0376$, therefore. Standard errors for ι are calculated by the Delta method, as in Arulampalam et al. (2012).

It is important to emphasize the crucial role of the value of $W/T_r = w/t_r$ in calculating the incidence effect. While we observe a value of 26.6 in our data, Arulampalam et al. (2012) report for Germany firm-specific means of $W = 57.51$ and $T = 14.92$, so that we obtain a ratio of only 3.855 (their cross-country full-sample ratio is about 5.3). This much lower number roots in aggregating all company tax payments, because Arulampalam et al. (2012) analyse the total business tax burden. This lower ratio is applied to a higher elasticity, because they estimate the effect of total (not only regional) taxation. Analysing the local tax burden, we only use the much lower local tax burden for this ratio, which explains the much higher ratio, compared to Arulampalam et al. (2012). Fuest et al. (2015) do not mention their exact calculation, but seem to use a ratio of $1/0.23 = 4.348$, applied to the higher extrapolated wage elasticity that refers to the total aggregated tax rate. Deducing the ratio for the total extrapolated elasticity in our case obtains 8.512, and is markedly higher than in the other two papers. That is, even for equivalent wage elasticities the stated incidence effect can vary quite significantly: the smaller the used ratio of wage sum to tax payments, the smaller the burden borne by labour. Therefore, very different wage-to-tax-bill ratios may represent another important source of diverging estimates for the incidence effect.

Table 7 also reports our results on the incidence effect in terms of percent, and the p-value of the t-test of the null hypothesis of a complete pass-through. With our ratio we obtain an incidence effect in a range of 65% to 82%, respectively even up to 93% by the 2-stage estimator. In contrast, applying the ratio of Fuest et al. (2015) to our elasticities, we obtain an incidence effect in a range of 32% to 46%, and with the ratio of Arulampalam et al. (2012) for Germany a range of 29% to 41% (39% to 56% using their cross-country ratio). That is, despite a similar or even lower estimated elasticity, we obtain a higher incidence estimation value, which simply roots in a higher wage-sum-to-corporate-tax-burden ratio. Although we estimate that labour only bears 65% to at most 93% of business taxation, and there are good reasons to assume that labour does not bear the total business tax burden, our t-tests reveal that, statistically, the null of a complete pass-trough cannot be rejected at conventional significance levels.

9 Conclusion

We provide comprehensive empirical evidence on the incidence of business taxation on wages. We combine individual labour market data with heterogeneous region-specific effective tax rates. The data set enables us to document (i) for the first time the effect of business taxation on wage inequality, (ii) the heterogeneity of the effect for different types of workers, and (iii) to provide first empirical evidence for an asymmetric business tax shifting for tax rate increases and decreases.

The average elasticity of wages with respect to changes of the local effective business tax rate ranges between -0.024 and -0.035, which corresponds with an extrapolated elasticity with respect to the total effective corporate tax rate at the federal level of -0.074 and -0.107. This is in line with the results of Arulampalam et al. (2012). In Germany, this corresponds with an incidence effect of 65% to 93%. Based on the average real daily gross wage in our sample, a change of the total business tax rate of 1% is associated with an inverted change of the average real yearly wage between €25 and €36, that is, between $27 and $40.[29] Applying the 1995-2004-average aggregated number of employees in Germany, this accumulated to a macroeconomic purchasing power of about €0.95 to €1.38 billion ($1.06 to $1.53 billion), which represents 0.05% to 0.07% of the 1995-2004-average real GNI in year 2000 prices, or 0.11% to 0.16% of the 1995-2004-average real payroll payments (compensation of employees minus employers' contributions to the social security system) in year 2000 prices.

We find robust evidence that tax rate increases involve significantly lower incidence effects than tax rate decreases, that is, they have asymmetric incidence effects. The effective regional corporate tax rate also has a significant positive effect on all wage inequality measures considered, that is, corporate taxation rises inequality. Corporate taxation is especially shifted toward workers who work in unskilled jobs, or who have accumulated already ten or more years of tenure. Job mobility is found to enable workers to elude tax shifting, so that especially employees who stay on their jobs are affected. Unemployment experience also increases the risk of suffering from corporate tax shifting. Additionally, we find significant differences between industries, which can be explained by a complex mix of different aspects. Therefore, business taxation has unintended redistributional effects on wages, never discussed in the public debate. Tax reductions for businesses, or the abolition of corporate taxation, may increase wages and reduce wage inequality, which produces purchasing power and, surprisingly, might improve social cohesion.

[29] The ten-year (1995 to 2004) average of the official exchange rates to the US-$ is 1.11 $/€.

References

Akerlof, G. A. and Yellen, J. L. (1990). The fair wage-effort hypothesis and unemployment, *Quarterly Journal of Economics* **105**(2): 255–283.

Altonji, J. G. and Devereux, P. J. (2000). The extent and consequences of downward nominal wage rigidity, *Research in Labor Economics*, Vol. 19, Emerald Group Publishing Limited, pp. 383–431.

Andrews, M. J., Gill, L., Schank, T. and Upward, R. (2008). High wage workers and low wage firms: Negative assortative matching or limited mobility bias?, *Journal of the Royal Statistical Society: Series A* **171**(3): 673–697.

Angrist, J. D. and Pischke, J.-S. (2009). *Mostly Harmless Econometrics: An Empiricist's Companion*, Princeton University Press.

Arulampalam, W., Devereux, M. P. and Maffini, G. (2012). The direct incidence of corporate income tax on wages, *European Economic Review* **56**(6): 1038–1054.

aus dem Moore, N. (2014). Shifting the burden of corporate taxes – heterogeneity in direct wage incidence, *Ruhr Economic Papers 531*, Ruhr-Universität Bochum, Technische Universität Dortmund, Universität Duisburg-Essen, and RWI Essen.

aus dem Moore, N., Kasten, T. and Schmidt, C. M. (2014). Do wages rise when corporate taxes fall? Evidence from Germany's Tax Reform 2000, *Ruhr Economic Papers 532*, Ruhr-Universität Bochum, Technische Universität Dortmund, Universität Duisburg-Essen, and RWI Essen.

Autor, D. H., Katz, L. F. and Kearney, M. S. (2006). The polarization of the U.S. labor market, *American Economic Review* **96**(2): 189–194.

Ballentine, J. G. (1978). The incidence of a corporation income tax in a growing economy, *Journal of Political Economy* **86**(5): 863–875.

Ballentine, J. G. and Eris, I. (1975). On the general equilibrium analysis of tax incidence, *Journal of Political Economy* **83**(3): 633–644.

Bargain, O., Orsini, K. and Peichl, A. (2012). Comparing labor supply elasticities in Europe and the US: New results, *IZA Discussion Paper 6735*, Institute for the Study of Labor (IZA),.

Baskaran, T. (2014). Identifying local tax mimicking with administrative borders and a policy reform, *Journal of Public Economics* **118**: 41–51.

Bauer, T., Bonin, H., Goette, L. and Sunde, U. (2007). Real and nominal wage rigidities and the rate of inflation: Evidence from West German micro data, *Economic Journal* **117**(524): F508–F529.

Bauer, T., Kasten, T. and Siemers, L.-H. R. (2012). Business taxation and wages: evidence from individual panel data, *IZA Discussion Paper 6717*, Institute for the Study of Labor.

Baumgarten, D. (2013). Exporters and the rise in wage inequality: Evidence from German linked employer-employee data, *Journal of International Economics* **90**(1): 201–217.

Behr, A. and Pötter, U. (2010). Downward wage rigidity in Europe: A new flexible parametric approach and empirical results, *German Economic Review* **11**(2): 169–187.

Bender, S., Haas, A. and Klose, C. (2000). IAB employment subsample 1975-1995. Opportunities for analysis provided by the anonymised subsample, *IZA Discussion Paper 117*, Institute for the Study of Labor (IZA),.

Besley, T. and Case, A. (1995). Incumbent behavior: vote-seeking, tax setting, and yardstick competition, *American Economic Review* **85**(1): 25–45.

Buettner, T. (2001). Local business taxation and competition for capital: the choice of the tax rate, *Regional Science and Urban Economics* **31**(2–3): 215–245.

Büttner, T. and Rässler, S. (2008). Multiple imputation of right-censored wages in the German IAB employment sample considering heteroscedasticity, *IAB Discussion Paper 44/2008*, Institute for Employment Research (IAB),.

Cahuc, P. and Zylberberg, A. (2004). *Labor Economics*, MIT Press.

Card, D., Kramarz, F. and Lemieux, T. (1999). Changes in the relative structure of wages and employment: A comparison of the United States, Canada and France, *Canadian Journal of Economics* **32**(4): 843–877.

Case, A. C., Rosen, H. and Hines, J. R. (1993). Budget spillovers and fiscal policy interdependence: Evidence from the states, *Journal of Public Economics* **52**(3): 285–307.

Castanheira, M., Nicodème, G. and Profeta, P. (2012). On the political economics of tax reforms: survey and empirical assessment, *International Tax and Public Finance* **19**(4): 598–624.

Chamberlain, G. (1994). Quantile regression, censoring, and the structure of wages, *in* C. Sims (ed.), *Advances in Econometrics*, Vol. 1, Cambridge University Press, chapter 5, pp. 171–208.

Ciccone, A. and Hall, R. E. (1996). Productivity and the density of economic activity, *American Economic Review* **86**(1): 54–70.

Clausing, K. A. (2013). Who pays the corporate tax in a global economy?, *National Tax Journal* **66**(1): 151–184.

Combes, P.-P., Duranton, G. and Gobillon, L. (2008). Spatial wage disparities: Sorting matters!, *Journal of Urban Economics* **63**: 723–742.

Cosciani, C. (1958/59). Zur Frage der Überwälzbarkeit einer Körperschaftsteuer, *Finanz-Archiv/Public Finance Analysis, New Series* **19**(2): 240–269.

Cowell, F. (2000). Measurement of inequality, *in* A. Atkinson and F. Bourguignon (eds), *Handbook of Income Distribution*, Vol. 1, Amsterdam: Elsevier, pp. 59–85.

Desai, M. A., Foley, C. F. and Hines, J. R. (2007). Labor and capital shares of the corporate tax burden: International evidence, *Conference on who pays the corporate tax in an open economy*, International Tax Policy Forum and Urban-Brookings Tax Policy Center.

Diamond, P. A. (1970). Incidence of an interest income tax, *Journal of Economic Theory* **2**(3): 211–224.

Dickens, W. T., Goette, L., Groshen, E. L., Holden, S., Messina, J., Schweitzer, M. E., Turunen, J. and Ward, M. E. (2007). How wages change: Micro evidence from the international wage flexibility project, *Journal of Economic Perspectives* **21**(2): 195–214.

Donald, S. G. and Lang, K. (2007). Inference with difference-in-differences and other panel data, *Review of Economics and Statistics* **89**(2): 221–233.

Dreher, A. and Gaston, N. (2008). Has globalization increased inequality?, *Review of International Economics* **16**(3): 515–536.

Dustmann, C., Ludsteck, J. and Schoenberg, U. (2009). Revisiting the German wage structure, *Quarterly Journal of Economics* **124**(2): 843–881.

Dwenger, N., Rattenhuber, P. and Steiner, V. (2013). Sharing the burden? Empirical evidence on corporate tax incidence, Max Planck Institute for Tax Law and Public Finance. Revised version of the 2011 MPI Working Paper 2011-14.

Ellguth, P. and Kohaut, S. (2005). Tarifbindung und betriebliche Interessenvertretung: Aktuelle Ergebnisse aus dem IAB-Betriebspanel, *WSI Mitteilungen* **7/2005**: 398–403.

Elsby, M. (2009). Evaluating the economic significance of downward nominal wage rigidity, *Journal of Monetary Economics* **56**(2): 154–169.

Evers, M., de Mooij, R. and van Vuuren, D. (2008). The wage elasticity of labour supply: A synthesis of empirical estimates, *De Economist* **156**(1): 25–43.

Federal Statistical Office (1999-2010). Realsteuervergleich, *Fachserie* **14**(Reihe 10.1). Wiesbaden: Federal Statistical Office Germany.

Federal Statistical Office (2004 and 2006). Verbraucherpreisindex für Deutschland, *Fachserie* **17**(Reihe 7). Wiesbaden: Federal Statistical Office Germany.

Fehr, E. and Gächtner, S. (2000). Fairness and retaliation: The economics of reciprocity, *Journal of Economic Perspectives* **14**(3): 159–181.

Fehr, E. and Goette, L. (2005). Robustness and real consequences of nominal wage rigidity, *Journal of Monetary Economics* **52**(4): 779–804.

Feldstein, M. (1974a). Incidence of a capital income tax in a growing economy with variable saving rates, *Review of Economic Studies* **41**(4): 505–513.

Feldstein, M. S. (1974b). Tax incidence in a growing economy with variable factor supply, *Quarterly Journal of Economics* **88**(4): 551–573.

Felix, R. A. (2007). Passing the burden: Corporate tax incidence in open economies, *Regional Research Working Paper 07-01*, Federal Reserve Bank of Kansas City.

Felix, R. A. and Hines, J. R. (2009). Corporate taxes and union wages in the United States, *Working Paper 15263*, National Bureau of Economic Research (NBER).

Fitzenberger, B., Haggeney, I. and Ernst, M. (1998). Wer ist noch Mitglied in Gewerkschaften? Eine Panelanalyse für Westdeutschland, *ZEW Discussion Paper 98-11*, Center for European Economic Research (ZEW).

Fitzenberger, B., Osikumino, A. and Völter, R. (2006). Imputation rules to improve the education variable in the IAB employment subsample, *Journal of Applied Social Science Studies (Schmollers Jahrbuch – Zeitschrift für Wirtschafts- und Sozialwissenschaften)* **126**(3): 405–436.

Foremny, D. and Riedel, N. (2014). Business taxes and the electoral cycle, *Journal of Public Economics* **115**: 48–61.

Friedlaender, A. F. and Vandendorpe, A. F. (1978). Capital taxation in a dynamic general equilibrium setting, *Journal of Public Economics* **10**(1): 1–24.

Fuchs, V. R., Krueger, A. B. and Poterba, J. M. (1998). Economists' views about parameters, values, and policies: Survey results in labor and public economics, *Journal of Economic Literature* **36**(3): 1387–1425.

Fuest, C., Peichl, A. and Siegloch, S. (2015). Do higher corporate taxes reduce wages?, *IZA Discussion Paper 9606*, Institute for the Study of Labor. Revised version of a discussion paper initially published in 2012.

Fullerton, D. and Metcalf, G. E. (2002). Tax incidence, *in* A. Auerbach and M. Feldstein (eds), *Handbook of Public Economics*, Vol. 4, Elsevier, pp. 1787–1872.

Gartner, H. (2005). The imputation of wages above the contribution limit with the German IAB employment sample, *FDZ Methodenreport 2/2005*, Centre for Research Data (FDZ) of the Federal Employment Agency.

Gartner, H. and Rässler, S. (2005). Analyzing the changing gender wage gap based on multiply imputed right censored wages, *IAB Discussion Paper 05/2005*, Institute for Employment Research (IAB).

Gentry, W. M. (2007). A review of the evidence on the incidence of the corporate income tax, *Working Paper 101*, Office of Tax Analysis.

German Council of Economic Experts (1996–2005). Annual reports, http://www.sachverstaendigenratwirtschaft.de.

Gibbons, S. and Overman, H. G. (2012). Mostly pointless spatial econometrics, *Journal of Regional Science* **52**(2): 172–191.

Glaeser, E. L., Kallal, H. D., Scheinkman, J. A. and Shleifer, A. (1992). Growth in cities, *Journal of Political Economy* **100**(6): 1126–1152.

Goette, L., Sunde, U. and Bauer, T. (2007). Wage rigidity: Measurement, causes and consequences, *Economic Journal* **117**(524): F499–F507.

Gordon, R. H. (1986). Taxation of investment and savings in a world economy, *American Economic Review* **76**(5): 1086–1102.

Gravelle, J. (2013). Corporate tax incidence: Review of general equilibrium estimates and analysis, *National Tax Journal* **66**(1): 185–214.

Gravelle, J. G. and Hungerford, T. L. (2011). Corporate tax reform: Issues for congress, *CRS report for congress*, Congressional Research Service (CRS).

Gravelle, J. G. and Smetters, K. A. (2006). Does the open economy assumption really mean that labor bears the burden of a capital income tax?, *B.E. Journal of Economic Analysis & Policy (Advances in Economic Analysis & Policy)* **6**(1): 1–42.

Guertzgen, N. (2009). Rent-sharing and collective bargaining coverage: Evidence from linked employer–employee data, *Scandinavian Journal of Economics* **111**(2): 323–349.

Harberger, A. C. (1962). The incidence of the corporation income tax, *Journal of Political Economy* **70**(3): 215–240.

Harberger, A. C. (1995). The ABCs of corporation tax incidence: Insights into the open economy case, *Tax Policy and Economic Growth*, Washington D.C.: American Council for Capital Formation, pp. 51–76.

Harberger, A. C. (2008). Corporation tax incidence: Reflections on what is known, unknown and unknowable, *in* J. W. Diamond and G. R. Zodrow (eds), *Fundamental Tax Reform: Issues, Choices, and Implications*, Cambridge: MIT Press, pp. 283–317.

Hassett, K. A. and Mathur, A. (2006). Taxes and wages, *Working paper no. 128*, American Enterprise Institute.

Heckel, T., Bihan, H. L. and Montornès, J. (2008). Sticky wages: Evidence from quarterly microeconomic data, *Working Paper 893*, European Central Bank.

Hirsch, B., Jahn, E. and Schnabel, C. (2013). The cyclical behaviour of employers' monopsony power, *IZA Discussion Paper 7776*, Institute for the Study of Labor (IZA).

Holden, S. (1994). Wage bargaining and nominal rigidities, *European Economic Review* **38**(5): 1021–1039.

Holden, S. (2003). Wage setting under different monetary regimes, *Economica* **70**(278): 251–265.

Holzmann, C. and von Schwerin, A. (2015). Economic integration and interdependence of tax policy, *Discussion Papers 14/2015*, Institute for Economic Policy and Quantitative Economic Research, Erlangen-Nuremberg.

Hoyt, W. (1992). Market power of large cities and policy differences in metropolitan areas, *Regional Science and Urban Economics* **22**(4): 539–558.

Hunt, J. (2001). Post-unification wage growth in East Germany, *Review of Economics and Statistics* **83**(1): 190–195.

Isen, A. (2014). Do local government fiscal spillovers exist? Evidence from counties, municipalities, and school districts, *Journal of Public Economics* **110**: 57–73.

IZA (2008). Geographic mobility in the European Union: Optimising its economic and social benefits, *Research Report 19*, Institute for the Study of Labor (IZA), Bonn.

Kahneman, D., Knetsch, J. and Thaler, R. H. (1986). Fairness as a constraint on profit seeking: Entitlements in the market, *American Economic Review* **76**(4): 728–741.

King, M. A. and Fullerton, D. (1984). The theoretical framework, *in* M. A. King and D. Fullerton (eds), *The Taxation of Income from Capital*, University of Chicago Press, pp. 7–30.

Klein, M. W., Moser, C. and Urban, D. M. (2013). Exporting, skills and wage inequality, *Labour Economics* **25**: 76–85.

Kloek, T. (1981). OLS estimation in a model where a microvariable is explained by aggregates and contemporaneous disturbances are equicorrelated, *Econometrica* **49**(1): 205–207.

Knoppik, C. and Beissinger, T. (2003). How rigid are nominal wages? Evidence and implications for Germany, *Scandinavian Journal of Economics* **105**(4): 619–641.

Kohaut, S. and Ellguth, P. (2008). Neu gegründete Betriebe sind seltener tarifgebunden, *IAB-Kurzbericht* **16/2008**: 1–8. Institute for Employment Research (IAB).

Laisney, F., Pohlmeier, W. and Staat, M. (1992). Estimation of labour supply functions using panel data: A survey, *in* L. Mátyás and P. Sevestre (eds), *The Econometrics of Panel Data*, Amsterdam: Kluwer, pp. 436–469.

Liang, K.-Y. and Zeger, S. L. (1986). Longitudinal data analysis using generalized linear models, *Biometrika* **73**(1): 13–22.

Liu, L. and Altshuler, R. (2013). Measuring the burden of the corporate income tax under imperfect competition, *National Tax Journal* **66**(1): 215–238.

Lyytikäinen, T. (2012). Tax competition among local governments: Evidence from a property tax reform in Finland, *Journal of Public Economics* **96**(7–8): 584–595.

Mieszkowski, P. M. (1967). On the theory of tax incidence, *Journal of Political Economy* **75**(3): 250–262.

Mincer, J. (1958). Investment in human capital and personal income distribution, *Journal of Political Economy* **LXVI**(4): 281–302.

Moulton, B. R. (1986). Random group effects and the precision of regression estimates, *Journal of Econometrics* **32**(3): 385–397.

Moulton, B. R. (1990). An illustration of a pitfall in estimating the effects of aggregate variables on micro units, *Review of Economics and Statistics* **72**(2): 334–338.

Munch, J. and Skaksen, J. (2008). Human capital and wages in exporting firms, *Journal of International Economics* **75**(2): 363–372.

Nickell, S. J. and Andrews, M. (1983). Unions, real wage and employment in Britain, *Oxford Economic Papers* **35**(suppl.): 183–206.

Ohlert, C. (2006). Die Beschäftigungsentwicklung in den Betrieben verschiedener Rechtsform, IAB – Ergebnisse aus dem Betriebspanel. Institute for Employment Research, Federal Employment Agency.

Randolph, W. C. (2006). International burden of the corporate income tax, *Working Paper 2006-9*, Congressional Budget Office.

Riedel, N. (2011). Taxing multinationals under union wage bargaining, *International Tax and Public Finance,* **18**(4): 399–421.

Schank, T., Schnabel, C. and Wagner, J. (2007). Do exporters really pay higher wages? First evidence from German linked employer-employee data, *Journal of International Economics* **72**(1): 52–74.

Shafir, E., Diamond, P. and Tversky, A. (1997). Money illusion, *Quarterly Journal of Economics* **112**(2): 341–374.

Shoven, J. B. and Whalley, J. (1972). A general equilibrium calculation of the effects of differential taxation of income from capital in the U.S., *Journal of Public Economics* **1**(3-4): 281–321.

Sinn, H.-W. (1987). *Capital Income Taxation and Resource Allocation*, Vol. 35 of *Studies in Mathematical and Managerial Economics*, North-Holland.

Steiner, V. and Wrohlich, K. (2004). Household taxation, income splitting and labor supply incentives: a microsimulation study for Germany, *CESifo Economic Studies* **50**(3): 541–568.

Stiglitz, J. E. (1976). The efficiency wage hypothesis, surplus labour, and the distribution of income in LDC's, *Oxford Economic Papers* **28**(2): 185–207.

Stiglitz, J. E. (2002). New perspectives on public finance: recent achievements and future challenges, *Journal of Public Economics* **86**: 341–360.

Suárez Serrato, J. C. and Zidar, O. (2016). Who benefits from state corporate tax cuts? A local labor markets approach with heterogeneous firms, *NBER Working Paper 20289*, National Bureau of Economic Research. Revised version of the July 2014 NBER working paper with the same number.

VGRdL (2010). Bruttoinlandsprodukt, Bruttowertschöpfung in den kreisfreien Städten und Landkreisen Deutschlands 1992 und 1994 bis 2009, *Research Group Regional Accounts of the 16 Statistical Offices of the Länder and the Federal Statistical Office* . Stuttgart: Statistical Office of Baden-Wurttemberg.

Vituschek, M. (2003). *Die Steuerbelastung von Personenunternehmen und Kapitalgesellschaften*, Ph.D. thesis, University of Mannheim.

von Schwerin, A. and Büttner, T. (2016). Constrained tax competition -– empirical effects of the minimum tax rate on the tax rate distribution, *Contributions to the Annual Meeting of the German Economic Association 2016*, German Economic Association.

White, H. (1980). A heterskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity, *Econometrica* **48**(4): 817–838.

Wilson, J. D. (1986). A theory of interregional tax competition, *Journal of Urban Economics* **19**(3): 296–315.

Woodcock, S. D. (2008). Wage differentials in the presence of unobserved worker, firm, and match heterogeneity, *Labour Economics* **15**(4): 771–793.

Zabel, J. E. (1997). Estimating wage elasticities for life-cycle models of labour supply behaviour, *Labour Economics* **4**(3): 223–244.

Zodrow, G. R. and Mieszkowski, P. (1986). Pigou, Tiebout, property taxation and the underprovision of local public goods, *Journal of Urban Economics* **19**(3): 356–370.

Table 1: Tax Parameters of Tax System, 1995-2004

Year	τ_{KSt} a)	σ	m b)	d	c_r c)	τ_r^{eff}	$\tau_{\text{corp}}^{\text{eff}}$	τ_{ESt} d)	$\tau_{\text{non}}^{\text{eff}}$	$\tau_{\text{weighted}}^{\text{eff}}$ e)
1995	0.450	0.075	0.05	0.0	3.71	0.156	0.564	0.387	0.507	0.551
1996	0.450	0.075	0.05	0.0	3.76	0.158	0.565	0.424	0.542	0.556
1997	0.450	0.075	0.05	0.0	3.80	0.159	0.566	0.424	0.542	0.560
1998	0.450	0.055	0.05	0.0	3.81	0.160	0.559	0.416	0.529	0.551
1999	0.400	0.055	0.05	0.0	3.82	0.160	0.514	0.406	0.519	0.516
2000	0.400	0.055	0.05	0.0	3.83	0.160	0.515	0.390	0.506	0.512
2001	0.250	0.055	0.05	1.8	3.83	0.160	0.382	0.361	0.400	0.386
2002	0.250	0.055	0.05	1.8	3.84	0.161	0.382	0.361	0.400	0.386
2003	0.265	0.055	0.05	1.8	3.86	0.161	0.396	0.361	0.401	0.397
2004	0.250	0.055	0.05	1.8	3.82	0.160	0.381	0.322	0.365	0.378
mean	0.362	0.061	0.05	0.7	3.81	0.159	0.487	0.385	0.476	0.485

Notes: a) – distributed profits were taxed at a reduced rate of 0.3 in the years 1995 to 2000. b) – for nonincorporated firms the base rate m was progressive with a tax allowance of €24,500; after that, the base rate started at 1% and increased by 1%-point each €12,000, so that the maximum rate of 5% was reached at €72,501. c) – average in the used IABS data, that is, over all observed employees. d) – the progressive income tax of nonincorporated firms is measured by the arithmetic mean of starting and top rate. e) – determined by weighted average of corporations' and nonincorporated firms' rate for each employee in the IABS data: $0.76 \cdot \tau_{corp}^{eff} + 0.24 \cdot \tau_{non}^{eff}$*, where* 0.76 *is the share of employees in corporations in total employment.*

Table 2: DESCRIPTIVE STATISTICS

Variable	Mean	(Std. Dev.)	Min.	Max.	N
Gross daily nominal wage	91.822	(42.356)	8.692	864.62	1,758,020
Gross daily real wage (2000=100)	91.541	(42.089)	9.121	836.190	1,758,020
log(Real gross daily wage)	4.423	(0.435)	2.211	6.729	1,758,020
Collection rate (c_r) in %	381.579	(56.797)	181	515	1,758,020
Effective regional tax rate (τ_{rt}^{eff})	0.160	(0.020)	0.083	0.205	1,758,020
log(τ_{rt}^{eff})	-1.842	(0.126)	-2.489	-1.586	1,758,020
Age in years	39.529	(9.840)	16	62	1,758,020
D(no vocational training)	0.083	(0.275)	0	1	1,758,020
D(high school degree)	0.716	(0.451)	0	1	1,758,020
D(secondary school)	0.068	(0.251)	0	1	1,758,020
D(university degree)	0.134	(0.340)	0	1	1,758,020
D(low-skilled workers)	0.25	(0.433)	0	1	1,758,020
D(blue-collar workers)	0.351	(0.477)	0	1	1,758,020
D(white-collar workers)	0.399	(0.490)	0	1	1,758,020
Number of establishments in life	3.686	(3.023)	1	84	1,758,020
Tenure in years	6.847	(6.944)	0.003	30.022	1,758,020
Occupation type	63.861	(31.580)	3	129	1,758,020
D(primary industry)	0.095	(0.293)	0	1	1,758,020
D(investment goods production)	0.225	(0.418)	0	1	1,758,020
D(consumer goods production)	0.060	(0.237)	0	1	1,758,020
D(food and allied industries)	0.026	(0.160)	0	1	1,758,020
D(building and construction trade)	0.123	(0.328)	0	1	1,758,020
D(distributive services)	0.118	(0.323)	0	1	1,758,020
D(communication & transport industries)	0.074	(0.261)	0	1	1,758,020
D(economic services)	0.129	(0.335)	0	1	1,758,020
D(social services)	0.086	(0.280)	0	1	1,758,020
D(other services)	0.064	(0.245)	0	1	1,758,020
D(1996)	0.117	(0.322)	0	1	1,758,020
D(1997)	0.118	(0.323)	0	1	1,758,020
D(1998)	0.119	(0.324)	0	1	1,758,020
D(1999)	0.107	(0.309)	0	1	1,758,020
D(2000)	0.117	(0.322)	0	1	1,758,020
D(2001)	0.120	(0.325)	0	1	1,758,020
D(2002)	0.113	(0.317)	0	1	1,758,020
D(2003)	0.114	(0.318)	0	1	1,758,020
D(2004)	0.073	(0.261)	0	1	1,758,020
log(value-added per employee)	10.701	(0.182)	10.153	11.464	1,758,020
Local competition (firms per employee)	1.240	(0.621)	0.243	3.792	1,758,020
Local unemployment rate in %	10.694	(4.628)	2.6	27.5	1,758,020
Firm density (firms per m^2)	0.422	(0.395)	0.009	2.198	1,758,020
Local number of employees (in 1,000)	240.905	(334.747)	18.5	1596.4	1,758,020
Tax rate changes and job movers					
D(changing[a] τ_r^{eff})	0.624	(0.484)	0	1	1,455,150
D(increasing τ_r^{eff})	0.423	(0.494)	0	1	1,455,150
D(decreasing τ_r^{eff})	0.201	(0.401)	0	1	1,455,150
D(constant τ_r^{eff})	0.376	(0.484)	0	1	1,455,150
D(job mover between counties)	0.073	(0.260)	0	1	1,638,100

The reported descriptive statistics for the final data set used for the analysis. D(·) represents dummy variables. – [a)] Share of observations where c_r differs between year t and $t-1$.

Table 3: BASIC SPECIFICATIONS

	(1)	(2)	(3)	(4)
wage elasticity(τ_r^{eff})	-0.1729***	-0.0815***	-0.0817***	-0.0286***
	(0.0359)	(0.0214)	(0.0211)	(0.0110)
		individual controls		
age	0.0498***	0.0487***	0.0482***	0.1915*
	(0.0010)	(0.0009)	(0.0009)	(0.1149)
age-squared	-0.0005***	-0.0005***	-0.0005***	-0.0005***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
D(no vocational training)	-0.0322***	-0.0306***	-0.0302***	-0.0289***
	(0.0037)	(0.0036)	(0.0035)	(0.0035)
D(secondary schooling)	0.0118***	0.0115***	0.0078*	0.0074*
	(0.0042)	(0.0042)	(0.0042)	(0.0042)
D(university degree)	0.1592***	0.1577***	0.1469***	0.1460***
	(0.0052)	(0.0051)	(0.0051)	(0.0050)
D(unskilled)	-0.0246***	-0.0245***	-0.0207***	-0.0208***
	(0.0018)	(0.0018)	(0.0016)	(0.0016)
D(white collar)	0.0813***	0.0808***	0.0744***	0.0739***
	(0.0022)	(0.0022)	(0.0022)	(0.0022)
plants counter	-0.0004	0.0001	0.0002	0.0004
	(0.0006)	(0.0005)	(0.0005)	(0.0005)
tenure	0.0094***	0.0099***	0.0099***	0.0101***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
tenure-squared	-0.0302***	-0.0323***	-0.0322***	-0.0331***
	(0.0011)	(0.0010)	(0.0010)	(0.0010)
		regional controls		
log(value-added p. employee)		-0.0062	-0.0051	0.0017
		(0.0099)	(0.0097)	(0.0073)
firms per employee		-0.0181***	-0.0169***	0.0032
		(0.0049)	(0.0048)	(0.0045)
unemployment rate		-0.0048***	-0.0047***	-0.0013**
		(0.0005)	(0.0005)	(0.0005)
firm density		-0.0715***	-0.0717***	-0.0974***
(establishments per m^2)		(0.0152)	(0.0152)	(0.0123)
employees		0.0005***	0.0005***	0.0004***
		(0.0001)	(0.0001)	(0.0001)
individual controls	Yes	Yes	Yes	Yes
regional controls	No	Yes	Yes	Yes
occupation fixed effects	No	No	Yes	Yes
NUTS2-year fixed effects	No	No	No	Yes
observations	1,758,020	1,758,020	1,758,020	1,758,020

*Dependent variable: log(real daily wage). Standard errors in parenthesis, clustered at the county level. All models include individual, county, sector, and year fixed effects, as well as a constant. Notation D(·) represents a dummy variable. Variable of interest: log(effective local business tax rate). *** significant at 1% level, ** significant at 5% level, and * significant at 10% level.*

Table 4: Socio-economic and Industry Effects

	elasticity(τ_r^{eff})	SE	Obs.
I. Socio-economic Effects (Saturated Model)			
A. Education			1,763,692
No Vocational Training	-0.0327	(0.0322)	
Vocational Training without Secondary Schooling	-0.0249***	(0.0095)	
Secondary Schooling with or w/o Vocational Train.	-0.0333	(0.0368)	
College/University Degree	0.0100	(0.0293)	
B. Occupational Status			1,763,692
Unskilled	-0.0331*	(0.0174)	
Blue-Collar	-0.0280**	(0.0114)	
White-Collar and Master Craftsmen	-0.0113	(0.0146)	
C. Tenure			1,763,692
Below 1 year	-0.0372	(0.0241)	
1 to below 5 years	-0.0228	(0.0149)	
5 to below 10 years	-0.0034	(0.0110)	
10 or more years	-0.0486*	(0.0249)	
D. Age			1,763,692
Aged 16-30	-0.0189	(0.0193)	
Aged 31-50	-0.0329***	(0.0115)	
Aged 51-62	0.0075	(0.0148)	
E. Unemployment Experience			1,763,692
No Unemployment Experience	-0.0173	(0.0120)	
With Unemployment Experience	-0.0312**	(0.0121)	
F. Job Mobility			1,638,100
Inter-County Job Switchers	-0.0051	(0.0249)	
Stayers	-0.0288***	(0.0110)	
II. Industry-Specific Effects (Sample Splits)			
Basic Goods and Other Consumption Goods	-0.0548	(0.0349)	167,280
Investment Goods Industry	0.0140	(0.0189)	396,945
Consumer Goods Industry	-0.0575*	(0.0298)	105,239
Food, Drinks and Tobacco	-0.0796**	(0.0331)	46,516
Construction Industry	-0.0299*	(0.0166)	217,102
Trade and Distributive Services	-0.0687***	(0.0210)	208,861
Transportation and Communication Industry	-0.0413	(0.0265)	129,835
Business Related Services	-0.0324	(0.0276)	227,674
Public, Health, Culture Services	-0.0066	(0.0227)	151,552
Other Services	-0.0260	(0.0241)	112,688

*Dependent variable: log(real daily wage). All standard errors in parentheses are clustered by county. In I, for each super group, for instance 'education,' a single regression has been run where for each subgroup, e.g. 'no vocational training,' all regressors has been included group-specifically (fully interacted model). In II, for each sector a single regression has been run, so that all regressors are sector-specific (sample split). Variable of interest: log(effective local business tax rate); individual controls: age and age squared, education dummies, occupational status dummies, individual plant counter, tenure and tenure squared; regional controls: log(value-added per employee), firms per employee, unemployment rate, firm density, east-west dummy, and number of employees; all models include individual, county, sector, year, and NUTS2-year fixed effects, as well as a constant. *** significant at 1% level, ** significant at 5% level, * significant at 10% level.*

Table 5: Inequality and Asymmetric Effects

	Dep. Var.:	Gini	GE(0)	GE(-1)	GE(1)
A. Inequality Effects	wage elasticity(τ_r^{eff})	0.0103**	0.0083***	0.0144***	0.0054**
		(0.0044)	(0.0028)	(0.0035)	(0.0027)
	Observations	1,763,692	1,763,692	1,763,692	1,763,692

	Dep. Var.:	log(real daily wage)
B. Asymmetric Effects	wage elasticity(τ_r^{eff} increases)	-0.0332***
		(0.0123)
	wage elasticity(τ_r^{eff} decreases)	-0.0341***
		(0.0124)
	Observations	1,455,150

*Standard errors in parenthesis, all clustered at the county level. All models include individual, sector, year, and occupation fixed effects, as well as a constant; in part A., county and NUTS2-year fixed effects are dropped, because the inequality measures vary at the county level; in part B., all models also include county and NUTS2-year fixed effects. The interaction term of the dummy D(neg) is highly significant. Variable of interest: log(effective local business tax rate). *** significant at 1% level, ** significant at 5% level, * significant at 10% level.*

Table 6: Robustness Checks

	(1)	(2)	(3)	(4)	(5)	(2-stage)[a)]
wage elasticity(τ_r^{eff})	-0.0276***	-0.0291***	-0.0308***	-0.0244**	-0.0268**	-0.0350***
	(0.0098)	(0.0109)	(0.0117)	(0.0107)	(0.0108)	(0.0133)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Regional controls	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	No	No	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	No	Yes	Yes
Occupational fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
County fixed effects	Yes	Yes	No	No	No	No
NUTS2-Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year fixed effects	Yes	No	No	No	No	Yes
Individual-Industry fixed effects	No	Yes	No	No	No	No
Individual-County fixed effects	No	No	Yes	No	No	No
Industry-County fixed effects	No	No	No	Yes	No	No
Occupation-County fixed effects	No	No	No	No	Yes	No
County-Year fixed effects	No	No	No	No	No	Yes
Observations	1,758,020	1,758,020	1,758,020	1,758,020	1,758,020	1,758,020[b)]

*Dependent variable: log(real daily wage). Standard errors in parenthesis, all clustered by county, with the exception of the 2-stage estimation. Variable of interest: log(effective local business tax rate); individual controls: age and age squared, education dummies, occupational status dummies, individual plant counter, tenure and tenure squared; regional controls: log(value-added per employee), firms per employee, unemployment rate, firm density, number of employees; the 2-stage regression includes county-year fixed effects on the first stage, which are regressed on the regional controls on the second stage. Notes: a) alternative 2-stage estimator with robust standard errors; b) number of observations on individual level (first stage); on the second stage (county level) it is 3,053. *** significant at 1% level, ** significant at 5% level.*

Table 7: EXTRAPOLATED ELASTICITY AND INCIDENCE EFFECT

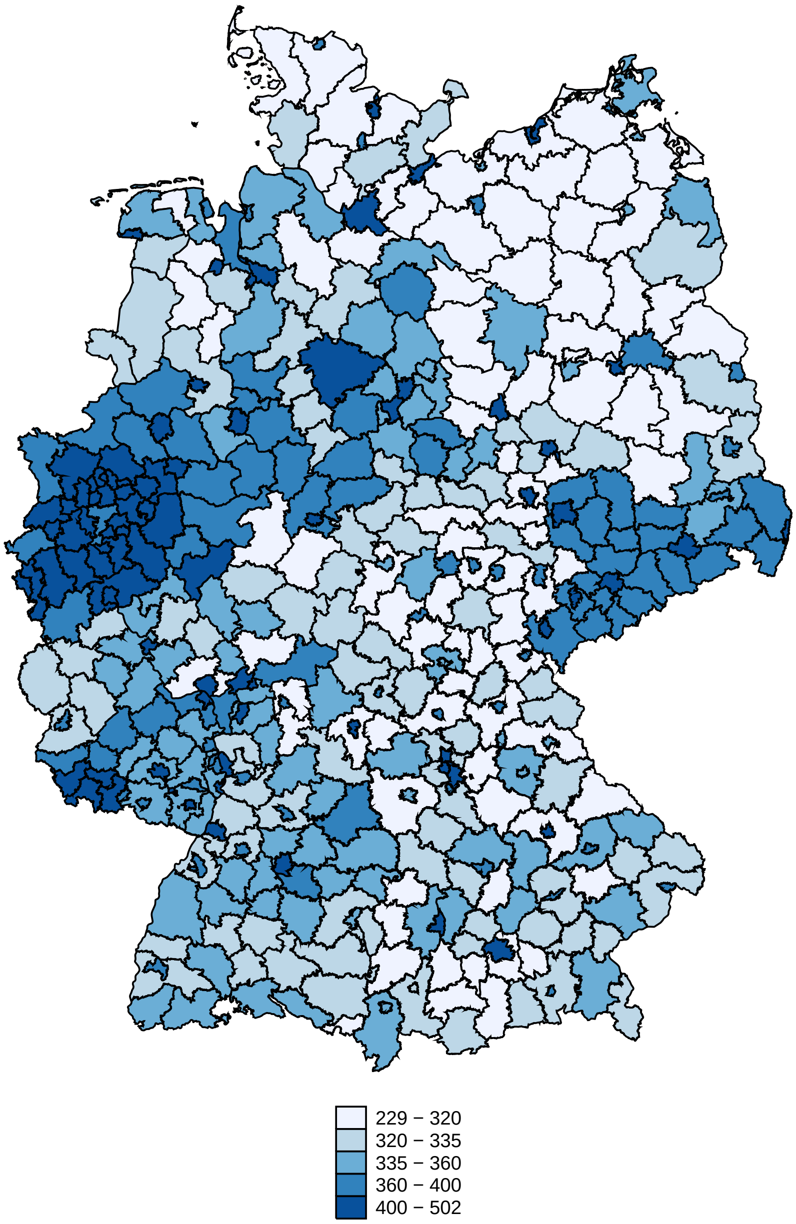
model	extrapolated elasticity	incidence	test: equal to 1? (p-value)
	Basic Specifications (Table 3)		
(1)	-0.5266***	-4.60***	0.000
	(0.1093)	(0.9547)	
(2)	-0.2483***	-2.17***	0.0409
	(0.0652)	(0.5692)	
(3)	-0.2489***	-2.17***	0.0375
	(0.0644)	(0.5619)	
(4)	-0.0871***	-0.76***	0.4148
	(0.0336)	(0.2932)	
	Robustness Checks (Table 6)		
(1)	-0.0841***	-0.73***	0.3087
	(0.0299)	(0.2609)	
(2)	-0.0886***	-0.77***	0.4343
	(0.0331)	(0.2893)	
(3)	-0.0939***	-0.82***	0.5644
	(0.0357)	(0.3117)	
(4)	-0.0743**	-0.65**	0.2176
	(0.0326)	(0.2850)	
(5)	-0.0816**	-0.71**	0.3184
	(0.0330)	(0.2885)	
(2-stage)	-0.1066***	-0.93***	0.8457
	(0.0405)	(0.3537)	

*Standard errors in parentheses, clustered at the county level in all models but the 2-stage regression, where they are robust; extrapolated wage elasticities, incidence effects, and all standard errors calculated by the Delta method. *** significant at 1% level, ** significant at 5% level, * significant at 10% level.*

Appendix

A Supplementary Figures

Figure 1: Distribution of the average collection rates at county level, in %



Data source: Real-Tax Statistics of the Federal Statistical Office

B Business Taxation of Nonincorporated Firms

The description of the German business taxation in the main text neglected the nonincorporated firms, that face a progressive income tax at the personal level of the owners ("Einkommensteuer," ESt). Only a fraction of about 20% of the employees is employed by nonincorporated firms, however (Ohlert 2006).

We denote the relevant income tax rate of nonincorporated firms by τ_{ESt}. In principle, business taxation of both incorporated and nonincorporated firms is quite similar, though there are some distinctive features beyond the difference of a flat rate compared to a progressive tariff. Owners of the nonincorporated firms also have to pay the "solidarity surcharge" σ, so that the overall federal tax rate is $(1+\sigma)\cdot\tau_{\text{ESt}}$. At the regional level, the base rate m of nonincorporated firms was not flat but a stepwise progressive tariff. Depending on the tax base, it started at 0% and increased up to 5% (the level of corporations) at a tax base of €72,500 in the analysed period, which the very most of the companies that employ many workers may cross. Hence, the marginal rate of 5% is the relevant for the very most of the employees. Like in the case of corporations, the effective statutory regional tax rate was given by $\tau_r^{\text{eff}}(c_r) = \tau_r(c_r)[1+\tau_r(c_r)]^{-1}$, due to the deductible regional tax liability. And the regional tax liability was also deductible from the federal tax base. For nonincorporated firms, equation (1) thus holds with τ_{ESt} instead of τ_{KSt} in the years before 2001, that is, in 60% of the analysed years. In 2001, the German government introduced the special rule that the regional basic-tax rate liability, that is $m(1-\tau_r^{\text{eff}})$, could additionally be deducted from the personal income tax by a factor d, in order to compensate nonincorporated firms for the drop of the corporate tax rate in the year 2001. Including this special feature of nonincorporated business taxation, we obtain

$$(5) \qquad \tau^{\text{eff}}(c_r) = (\tau_{\text{ESt}} - d\cdot m)\cdot(1+\sigma) + [1-(\tau_{EST} - d\cdot m)\cdot(1+\sigma)]\cdot\tau_r^{\text{eff}}(c_r)$$

with $\partial\tau^{\text{eff}}/\partial c_r = [1-(1+\sigma)(\tau_{\text{ESt}}-dm)]\cdot m/(1+mc_r)^2$. Note that the special deduction does reduce the personal income tax burden, but not the regional business tax burden. Despite the special deduction, most nonincorporated companies faced an overall extra burden due to the regional tax, that increased for a given τ_r^{eff} when the individual tax rate τ_{ESt} decreased (Vituschek 2003). Hence, $\partial\tau^{\text{eff}}/\partial c_r > 0$ for any realistic parameter constellation. Therefore, as in the case of corporations, the effective tax burden of nonincorporated firms is an increasing function of the regional collection rate c_r. The tax parameters for nonincorporated firms are also summarized in Table 1. It is important to note that we exploit the variation of the effective regional tax rate τ_r^{eff}, and not of the total tax rate.

C A Wage Bargaining Model with Heterogeneous Employee Groups

The described German wage determination process suggests a wage bargaining model with heterogeneous labour at a regional industry level. It also suggests a right-to-manage model (e.g., Nickell and Andrews 1983), where employer associations and trade unions bargain over wage levels, but the firms are free to determine their optimal employment level afterwards.

Let the representative production function of a firm in an industry be $F(K, L_1, \ldots, L_N)$, where the inputs are capital K and N different groups of employees L_n, $n = \{1, 2, \ldots, N\}$. The respective wage rates w_n are negotiated between a trade union and an association. The function $F(\cdot)$ follows the standard assumptions of $\frac{\partial F(\cdot)}{\partial X} > 0$ and $\frac{\partial^2 F(\cdot)}{\partial X^2} < 0$, with $X = K, L_1, \ldots, L_N$. Firms may have market power and face the inverse good demand function $p(Y)$ with $\frac{\partial p(Y)}{\partial Y} < 0$, where Y is the good demand that equals output $F(\cdot)$ in equilibrium. The interest rate is given by r. A firm's gross profit is obtained as $p(Y) \cdot Y - \sum_{n=1}^{N} w_n \cdot L_n - r \cdot K$. This gross profit is reduced to net profit after reduction of tax liability $\tau^{\text{eff}} \cdot \left[p(Y) \cdot Y - \sum_{n=1}^{N} w_n \cdot L_n - \alpha r K\right]$, where α represents the fraction of gross capital cost rK that is deductible from the tax base; in Germany, taxation is non-neutral with $0 < \alpha < 1$. Labour costs are completely deductible in Germany. For net profits π we thus obtain:

$$\pi = (1 - \tau^{\text{eff}}) \left[p(Y) \cdot F(K, L_1, \ldots, L_N) - \sum_{n=1}^{N} w_n L_n - w_K K\right] \qquad (6)$$

where the user costs of capital, labelled w_K, are given by $(1 - \alpha\tau^{\text{eff}}) \cdot r / (1 - \tau^{\text{eff}}) = (1 + \tilde{\tau})r$, where $\tilde{\tau} = (1 - \alpha)\tau^{\text{eff}} / (1 - \tau^{\text{eff}})$ is the effective marginal tax rate (EMTR) on marginal gross cost of capital r.[30] In negotiating wages, the employer association maximizes this net profit. The trade union represents all employee groups and maximizes the wage sum. The bargaining power of the trade union is given by γ and all groups' wages are negotiated simultaneously by the same union. Given that different employee groups display different levels of membership and the negotiating agent of the union is interested in re-election, we assume that the agent may put different weights to different employee groups. We define the weight of employee group n applied by the trade union by $(1 + a_n)/N$ for groups $n = 1, \ldots, N$ with $a_N = -\sum_{n=1}^{N-1} a_n$, i.e., a_n measures the rate of deviation from equal

[30] Capital cost typically also deviate depending on the financing structure of firms, because taxation is not neutral with respect to the source of financing (e.g., King and Fullerton 1984).

weights. We assume Nash bargaining and that the bargained outcome is determined by maximization of the Nash product, weighted by the respective bargaining powers. We follow standard practice and assume that the fall-back levels of the union are the respective group-specific non-agreement wages, denoted by $\overline{w}_n$, and that the firms make no profits in case of disagreement. The interior solution is thus obtained by maximizing the logarithm of the weighted Nash product, where the maximization problem can be expressed as:

$$(7) \quad \max_{\{w_1,\ldots,w_N\}} \quad \frac{\gamma}{N}\left\{(1+a_1)\ln[(w_1-\overline{w}_1)L_1]+\ldots+\left(1-\sum_{n=1}^{N-1}a_n\right)\ln[(w_N-\overline{w}_N)L_N]\right\} + (1-\gamma)\pi(w_1,\ldots,w_N,w_K),$$

taking into account the firms' labour and capital demands that are implicitly determined by the $N+1$ respective first order conditions of the firm, given by $p/v \cdot F_{L_n} = w_n$ and $p/v \cdot F_K = w_K(\tau,\alpha,r)$. Variable $v = 1/(1+\eta_Y^p) \geq 1$ represents the mark-up of the firms, given the elasticity of the inverse good demand function $\eta_Y^p < 0$, and $n = 1,\ldots,N$. The markup v is a measure for market power, where $v = 1$ represents perfect competition. Additional constraints of the problem are $w_n \geq \overline{w}_n$ for all $n = 1,\ldots,N$.

We solve the maximization problem in two steps. First we deduce the optimal wage agreement for a given allocation of the $N+1$ inputs of the industry. Arulampalam et al. (2012) appoint this effect the direct effect. In the second step, we deduce the optimal re-allocation of inputs, given these wage levels, in response to a change in the collection rate c_r. Given fixed allocation of capital and labour, the direct effect is a short-term effect, while, in the long run, the labour and capital demands are adjusted.

C.1 Short-Term Model: the Direct Effect

We define $\gamma_n \equiv (1+a_n)\gamma/N$ for $n = 1,\ldots,N$ and obtain:

Proposition 1. *For a given allocation of the input factors $(K, L_1,\ldots,L_n)$ the optimal wage agreement consists of the wage rates*

$$w_n^{Nash} = \overline{w}_n + \frac{\gamma_n}{L_n}\left[pY - \sum_{i=1}^{N}\overline{w}_i L_i - w_K(\tau,\alpha,r)K\right]$$

for the $n = 1,\ldots,N$ groups of employees.

Proposition 1 replicates the standard result that the bargained wage is the fall-back wage plus the per employee rent earned by the firms weighted by the bargaining power of the union. In our case with heterogeneous employee groups, it is the group specific fall-back wage and the group-specific part of the rent. If the union has no power at all ($\gamma = 0$) each employee group is paid the fall-back wage $\overline{w}_n$. If the trade union has monopolistic power ($\gamma = 1$), each employee group will additionally receive $(1 + a_n)/N$ times the group specific per capita rent. Following Proposition 1, a change in the regional collection rate involves a negative effect on all employee groups amounting to:

$$\frac{\partial w_n^{\text{Nash}}|_{Y=\overline{Y}}}{\partial c_r} = -\gamma_n \cdot \frac{K}{L_n} \cdot \frac{\partial w_K(\tau^{\text{eff}})}{\partial \tau^{\text{eff}}} \cdot \frac{\partial \tau^{\text{eff}}(c_r)}{\partial c_r} < 0. \tag{8}$$

As has been shown above, an increase in the regional collection rate will increase the relevant effective overall tax rate τ^{eff}, which in turn increases capital cost w_K, where $\partial w_K / \partial \tau^{\text{eff}} = (1 - \alpha) r / (1 - \tau)^2$. Given that increased capital costs reduce the rent each employee group shares in, the increased tax burden is shifted to the respective employee groups.

In the second step, the negotiation partners take into account the induced re-allocation effects. Given that the German tax system is non-neutral, the relative prices between capital and all other input factors are distorted. We argue that this effect will only occur in the long-run. In the next section we show that the direction of this effect is, *a priori*, indetermined. In the short-run, however, the deduced negative direct effect of taxation on wages will clearly dominate.

C.2 The Reallocation Effect in the Long Run

Following the literature surrounding the Hicks-Marshall laws of factor demand, a change of a factor price typically involves a substitution and scale effect. In a multi-input setting, the overall effect of a change of the user cost of capital w_K on the respective labour demands L_n, $n = 1, 2, \ldots, L_N$, is more complex, because inputs can be gross substitutes or gross complements. We define s_j as input j's portion of total factor cost, and σ_j^i as the partial elasticity of substitution in the Allen's sense, with $i, j = \{K, L_1, \ldots, L_N\}$. It has been proved that (cf. Cahuc and Zylberberg 2004: 193):

Lemma 1. *Given the production function is homogeneous at degree θ, the optimal elasticity of the unconditional labour demand L_n with respect to capital cost w_K, denoted $\eta_{w_K}^{L_n}$, is*

$$\eta_{w_K}^{L_n} = s_K \left(\sigma_K^{L_n} - \frac{v}{v - \theta} \right).$$

Therefore, labour demand L_n will rise if K and L_n are gross substitutes ($\sigma_K^{L_n} > \frac{v}{v-\theta}$) and decrease if they are gross complements. This re-allocation effect increases with the degree of market power v in absolute terms. We denote the rent $pY - \sum_{i=1}^N \overline{w}_i L_i - w_K K$ by R and obtain the following term for the total group-specific corporate income tax incidence effect, caused by a regional change of c_r:

Proposition 2. *The total corporate tax incidence effect of a marginal change of c_r in a Nash bargaining setting is given by:*

$$\frac{\partial w_n^{Nash}}{\partial c_r} = \underbrace{\frac{\partial w_n^{Nash}|_{Y=\overline{Y}}}{\partial c_r}}_{(-)} + \frac{\gamma_n}{L_n} \left\{ \sum_{i=1}^N \left[(w_i^{Nash} - \overline{w}_i) s_K \left(\sigma_K^{L_i} - \frac{v}{v-\theta} \right) \frac{L_i}{w_K} \right] - \frac{R}{L_n} s_K \left(\sigma_K^{L_n} - \frac{v}{v-\theta} \right) \frac{L_n}{w_K} \right\} \cdot \frac{\partial w_K}{\partial \tau^{eff}} \frac{\partial \tau^{eff}}{\partial c_r}.$$

Proof. Forming the first derivative of w_n^{Nash} with respect to τ^{eff}, reminding $p/v \cdot \frac{\partial F(\cdot)}{\partial K} = w_K$, and $p/v \cdot \frac{\partial F(\cdot)}{\partial L_n} = w_n^{\text{Nash}}$ we obtain:

$$\frac{\partial w_n^{\text{Nash}}}{\partial \tau^{\text{eff}}} = \underbrace{\frac{\partial w_n^{\text{Nash}}|_{Y=\overline{Y}}}{\partial c_r}}_{(-)} + \frac{\gamma_n}{L_n} \left\{ \sum_{i=1}^N \left[(w_i^{\text{Nash}} - \overline{w}_i) \frac{\partial L_i}{\partial \tau^{\text{eff}}} \right] - \frac{R}{L_n} \frac{\partial L_n}{\partial \tau^{\text{eff}}} \right\}. \tag{9}$$

We know that $\eta_{c_r}^{L_i} = \frac{\partial L_i}{\partial w_K} \frac{w_K}{L_i} \cdot \frac{\partial w_K}{\partial c_r} \frac{c_r}{w_K} = \eta_{w_K}^{L_i} \cdot \eta_{c_r}^{w_K}$. Applying Lemma 1 we obtain $\eta_{c_r}^{L_i} = s_K(\sigma_K^{L_i} - v/(v-\theta)) \cdot \eta_{c_r}^{w_K}$, so that $\frac{\partial L_i}{\partial c_r} = s_K(\sigma_K^{L_i} - v/(v-\theta)) \cdot \frac{L_i}{w_K} \frac{\partial w_K}{\partial c_r}$, which completes the proof. □

If we assume that labour is a gross substitute to capital, that is $\sum_{i=1}^N (w_i^{\text{Nash}} - \overline{w}_i) \frac{\partial L_i}{\partial \tau^{\text{eff}}} > 0$, respectively $\sum_{i=1}^N \left[(w_i^{\text{Nash}} - \overline{w}_i) s_K \left(\sigma_K^{L_i} - \frac{v}{v-\theta} \right) \frac{L_i}{w_K} \right] > 0$, the firms are able to partly elude taxation via substituting capital by labour. Then, *ceteris paribus*, the incidence effect decreases in absolute terms. Otherwise, labour and capital are, in the aggregate, complements and firms reduce labour demand together with the more expensive capital, instead of increasing labour demands. Lower levels of labour inputs reduce the rent further, so that even more of the profit tax burden is shifted to the employees via reduced wages. Finally, if L_n itself is a gross substitute to capital, that is $\sigma_K^{L_n} - \frac{v}{v-\theta} > 0$, we see that the incidence effect increases in absolute terms, all other things equal. The reason is that then the term γ_n/L_n in the wage function in Proposition 1 is decreasing due to rising labour demand L_n. The consequence is that the rent R is group-specifically distributed to more employees, so that the per capita rent and thus the wage shrinks additionally. While the first term focusing on aggregate gross substitutability of labour to capital covers the effect on the absolute rent R, the group-specific second term of substitutability of labour group n refers, beyond that, to the additional group-size effect: if demand L_n is rising, the rent is distributed to more employees, so that the single group member receives lower wages. If L_n itself is a gross complement, in contrast, the tax incidence effect decreases in absolute terms, because R/L_n is rising, *ceteris paribus*. Hence, the incidence effect is complex. L_n can be a gross complement to capital or a gross substitute, and, at the same time, labour in general can be a gross complement or substitute in the aggregate as well, so that there are four possible constellations. Which of these constellations is the valid highly depends on the industry specific technologies, so that the reallocation effect can amplify as well as dampen the tax shifting behaviour of the firms. If there are adjustment cost for labour and capital, that involve a convex cost function, factor demands are adjusted only gradually. Therefore, the re-allocation effect of corporate taxation at the second stage ought to arise only with a time lag, so that we expect the negative direct effect to dominate in the short-run.

D Technical Details on Wage-Inequality Measures

We calculate two types of parametric indices of wage inequality: generalised entropy inequality indices and the famous Gini inequality index. While the former type is a fully axiomatic approach, the Gini is a 'statistical' index. Consider there are L employees l ($l = 1, \cdots, L$) with wage w_l. The mean wage is $\overline{w}$. The Generalised Entropy Class wage inequality index includes an inequality aversion parameter a to be chosen. The index $GE(a)$ is defined as:

$$GE(a) = \begin{cases} \frac{1}{a \cdot (a-1)} \cdot \left[\frac{1}{L} \cdot \sum_{l=1}^{L} \left(\frac{w_l}{\overline{w}} \right)^a - 1 \right] & \text{if} \quad a \neq 0 \text{ or } a \neq 1 \\ \frac{1}{L} \cdot \sum_{l=1}^{L} \log \left(\frac{\overline{w}}{w_l} \right) & \text{if} \quad a = 0 \\ \frac{1}{L} \cdot \sum_{l=1}^{L} \left(\frac{w_l}{\overline{w}} \right) \cdot \log \left(\frac{w_l}{\overline{w}} \right) & \text{if} \quad a = 1 \end{cases} \qquad (10)$$

That is, in our special case of $a = -1$ we obtain $GE(-1) = \frac{1}{2} \cdot \frac{1}{L} \cdot \sum_{l=1}^{L} \left(\frac{\overline{w}}{w_l} \right)$. Parameter a specifies the sensitivity to differences of wage. Large values $a > 0$ correspond to a greater sensitivity to high wages, while small values $a < 0$ correspond to a higher sensitivity to low values of wage. With parameter $a = 0$, we obtain the 'mean logarithmic deviation' $GE(0)$, that is sensitive in the 'middle' of the distribution of wages. Therefore, choosing $a = -1, 0, 1$ we focus inequality effects at the bottom ($a = -1$), the middle ($a = 0$), and the top of the wage distribution ($a = 1$, Theil index).

The famous Gini index G, in turn, is calculated as:

$$G = \frac{1}{L} \cdot \left[L + 1 - \frac{2}{\overline{w} \cdot L} \cdot \sum_{l=1}^{L} (L + 1 - l) \cdot w_l \right] \tag{11}$$

To apply this formula, it is required that the observed employees in the data are sorted by ascending order of wage w_l. The Gini index is most sensitive for changes around the mode of the distribution, that is, the Gini index is middle-sensitive, as is $GE(0)$.