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Do Higher Corporate Taxes Reduce Wages? Micro Evidence from Germany

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ABSTRACT

Do Higher Corporate Taxes Reduce Wages? Micro Evidence from Germany*

Because of endogeneity problems very few studies have been able to identify the incidence of corporate taxes on wages. We circumvent these problems by using an 11-year panel of data on 11,441 German municipalities' tax rates, 8 percent of which change each year, linked to administrative matched employer-employee data. Consistent with our theoretical model, we find a negative effect of corporate taxation on wages: a 1 euro increase in tax liabilities yields a 77 cent decrease in the wage bill. The direct wage effect, arising in a collective bargaining context, dominates, while the conventional indirect wage effect through reduced investment is empirically small due to regional labor mobility. High and medium-skilled workers, who arguably extract higher rents in collective agreements, bear a larger share of the corporate tax burden.

JEL Classification: H2, H7, J3

Keywords: business tax, wage incidence, administrative data, local taxation

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1 Introduction

The debate about who bears the burden of corporate taxation has recently shifted from the theoretical to the empirical arena. A large number of theoretical contributions inspired by Harberger (1962)'s seminal paper suggest that labor bears a substantial share of the corporate tax burden.[1] However, there are only few empirical studies on the wage incidence of corporate taxation. The main reason for this lack of empirical evidence is that measuring the effect of corporate taxation on wages raises a number of difficult conceptual and econometric issues. First, conceptually, it is important to distinguish between different channels through which corporate taxes can affect wages. For instance, most theoretical studies emphasize that corporate taxes reduce wages because they reduce investment. But taxes may also affect the wage setting process, depending on the way in which wages are determined. Then there may be general equilibrium effects of tax changes on wages and prices. Second, there needs to be sufficient exogenous variation in corporate tax rates. Third, the analysis must control appropriately for the economic environment in which the tax changes occur. Clearly, the latter two conditions are necessary to establish a quasi-experimental setting which is crucial for identification.

It is difficult to find a research design dealing with all of these issues in a satisfactory manner. One avenue is to use cross-country data (Hassett and Mahur, 2006; Felix, 2007; Desai et al., 2007), which is helpful to capture general equilibrium effects. Yet, cross-country studies on the wage incidence of corporate taxes usually exploit differentials in country-specific tax rates over time and therefore often have troubles to defend the common trend assumption: in general, it is not likely that differences in the wage growth paths of e.g. Germany and the U.S. can be purely attributed to changes in national corporate tax policies.

An alternative to using cross-country data is to look at a single country and to exploit regional and/or industry-specific variation in corporate taxes to identify the wage incidence (Dwenger et al., 2011; Liu and Altshuler, 2013). Here, the common trend assumption is arguably more credible, while the variation in tax rates is often not as clear as in the first group of studies. The influential paper by Arulampalam et al. (2012) acknowledges this problem by exploiting both cross-firm and cross-

[1] The literature following Harberger (1962) extended the model to the open economy case (Diamond and Mirrlees, 1971; Bradford, 1978; Kotlikoff and Summers, 1987; Harberger, 1995), incorporated more sectors (Shoven, 1976) and introduced uncertainty (Ratti and Shome, 1977). Surveys are provided by Auerbach (2005) and Harberger (2006). Recent computational general equilibrium (CGE) models find that labor bears a substantial share of the corporate tax burden under reasonable assumptions (see Gravelle, 2013, for an overview).

country variation in tax burdens. Nevertheless, as the authors admit, studies using cross-country firm data are normally not able to capture the general equilibrium effects of national corporate taxes. Therefore the authors focus on what they call the direct wage effect, which arises in a collective bargaining setting. The analysis leaves aside the indirect wage effect through investment as well as other general equilibrium effects on prices and other relevant variables.

In this paper, we exploit the specific institutional setting of the German local business tax – the most important profit tax in terms of revenue – to achieve a clean identification of the full corporate tax incidence on wages.[2] From 1998 to 2008, on average 8% of the 11,441 German municipalities adjusted their local business tax rates per year. These municipalities face the same overall economic conditions and are therefore comparable so that the necessary common trend assumption is likely to hold.[3] Moreover, local corporate tax autonomy allows us to treat municipalities as many small open economies within the highly integrated German national economy – with close to perfect mobility of capital and labor across (municipal) borders. We are thus confident to measure the full incidence of corporate tax changes, not just the direct effect. The reason is that general equilibrium effects on interest rates and other variables that might affect wages will be negligible in this setting.

We set up a theoretical model that allows us to study the incidence of a local corporate tax in an economy with different types of labor (skilled and unskilled) and where wages in some firms are determined through collective bargaining. In the model the full incidence of corporate taxation can be decomposed into a direct effect related to rent division in collective bargaining and an indirect effect through the adjustment of investment and employment. We then test the theoretical model combining administrative panel data on the universe of the German municipalities with rich administrative linked employer-employee microdata taken from German social security records.

Our empirical findings are as follows: First, in line with the theoretical model, we find parametric and non-parametric evidence for a sizeable direct wage effect of corporate taxation in firms with collective bargaining. We estimate a wage elasticity with respect to the effective corporate tax rate of -0.35. In money terms this implies that a one euro increase in annual tax liabilities yields a 50 cent decrease of the annual wage bill, which is in line with findings of other recent studies (Arulampalam

[2] See, e.g., Büttner (2003); Janeba and Osterloh (2012) for studies analyzing this specific tax.

[3] A similar set-up is used by Felix and Hines Jr. (2009) who exploit the variation in corporate tax rates among U.S. states. Yet, their results are based on a single cross-section, which makes it impossible to control for potential state fixed effects.

et al., 2012; Liu and Altshuler, 2013). The incidence increases to 67 cents when including one lag of the corporate tax rate. Second, we find only a small indirect effect on wages. This is consistent with labor being mobile across municipal borders.[4] In sum, we estimate a full incidence, consisting of the direct and indirect effect, of 77 cents, which means that raising one euro of corporate tax revenue reduces local wages in unionized firms by about three quarters of the revenue raised.

The negative direct wage effect is larger if collective bargaining takes place at the firm level rather than at the sectoral level, which is in line with the theoretical model. High and medium-skilled workers experience relatively higher wage losses than low-skilled workers if corporate tax rates increase. One explanation would be that medium and high-skilled workers have more bargaining power and thus capture a higher share of the rent generated by the firm so that they also lose more if taxes diminish this rent. We run several tests to show that our estimates are well-identified. Reassuringly, including job or labor market region time trends does not render our estimates, which makes it unlikely that our estimates are biased by unobserved, time-variant confounders. Moreover, a placebo test on non-liable firms shows a zero effect of the local business tax on wages.

Our study adds to the existing literature in four dimensions. First and most importantly, this is the first study on the wage incidence of corporate taxes using linked employer-employee data. In addition to administrative wage data, exploiting firm information is crucial to (i) take into account that only certain types of firms pay the local business tax while other types of firms are exempt by law, (ii) identify the wage setting and collective bargaining status of the firm, (iii) differentiate between corporate and non-corporate firms. Moreover, we are able to estimate heterogeneous worker and firm effects. Second, this study is the first to exploit compelling variation in tax rates induced by numerous local tax reforms in order to cleanly identify the tax incidence on wages, while keeping the overall economic environment constant.[5] Third, the particular institutional setting of the German business tax allows us to

[4] Intra-regional employment effects of the German local business tax are analyzed in a companion paper (Siegloch, 2013).

[5] The only other study with a similar set-up is Bauer et al. (2012), which was conducted simultaneously and independently of our study (cf. the earliest version of this study Fuest et al., 2011). The author are also investigating the German local business tax. A closer look at Bauer et al. (2012) shows, however, that they do not have information on the municipality (*Gemeinde*) in their data. Hence, they estimate their model using average tax rates on the more aggregate county (*Kreis*) level (there are roughly 11,400 municipalities vs. 400 counties). This makes the variation imprecise since annual tax changes occurring in only 8% of the municipalities lead to variation of average tax rates in 65-75% of the counties. Thus, firms (and wages) in unaffected municipalities are wrongly exposed to the county's average changes. Moreover, the authors are lacking relevant firm information since they are not using linked employer-employee data.

estimate the full wage incidence taking into account both the direct and the indirect effect of corporate tax changes. Finally, in our theoretical analysis, we extend the model of Arulampalam et al. (2012) by allowing for different skill levels and by distinguishing between firm and sector level bargaining.

The rest of the paper is structured as follows. In Section 2 we describe the German corporate tax legislation with a focus on the German local business tax and give a short overview of wage bargaining arrangements in Germany. In Section 3 we set up a theoretical wage bargaining model that features the particular German setting to demonstrate how municipal corporate taxes affect the wages of heterogeneous workers. Section 4 presents the datasets. Empirical results are shown and discussed in Section 5, while Section 6 concludes.

2 Institutional background

2.1 Corporate taxation in Germany

Corporate firms (*Kapitalgesellschaften*) face two profit taxes in Germany, the local business tax (LBT, *Gewerbesteuer*) set by municipalities and the corporate tax (CT, *Körperschaftstuer*) levied by the federal government. The LBT is the most important profit tax in Germany generating more than 50% of total business tax revenue. In addition, it is the most important source of financing at disposal of municipalities generating roughly three quarters of municipal tax revenue.

The LBT applies to both corporate and non-corporate firms (*Personengesellschaften*)[6], while most firms in the agricultural and public sector are not liable to the LBT. Moreover, certain liberal professions such as journalists, physicians or lawyers are exempt. The tax base, Y, is the same for both LBT and CT and essentially consists of operating profits since 1998.[7] For the LBT the tax base of firms with multiple establishments is divided between municipalities according to formula apportionment based on the wage bill of the individual establishments. Importantly, until 2007 a firm could deduct the LBT (but not the CT) payments from the common tax base. The tax rate of the LBT, τ_{LBT}, consists of two components: the basic federal rate (*Steuermesszahl*), τ_{fed}, which is set at the national level, and the collection rate (*Hebesatz*), cr, set at the local level. Thus $\tau_{LBT} = \tau_{fed} \cdot cr$. τ_{fed} was at 5.0% from 1998 to 2007 and decreased to 3.5% in 2008. The collection rate usu-

[6] Taxation of non-corporate firms will be discussed in Section 5.6.

[7] Depending on the year, only a certain share of interest payments is deductible.

ally varied between 250% and 450% in the period from 1998 to 2008 (5th and 95th percentiles).[8] The collection rates for year t are passed by the municipal councils during the budgeting for t, which usually take places in the last three months of year $t-1$. It is important to note that a municipality can only adjust the collection rate which applies to all (liable) firms in the municipality; it can neither change the tax base nor liability criteria, which are both set at the federal level.

The CT rate, τ_{CT}, has undergone several changes in recent years. Until 2000 an imputation system existed in Germany, where retained profits where subject to a tax rate of 45% in 1998 and 40% in 1999 and 2000 – dividends were taxed at a rate of 30% from 1998 to 2000. As of 2001 retained and distributed profits were equally taxed at 25% (26.5% in 2003). In 2008 τ_{CT} was lowered to 15%. In all years, a so-called solidary surcharge (to finance the costs of reunification), $soli$, of 5.5% of the corporate tax rate is added.

In order to calculate the total effective statutory tax rate for corporate firms, first, LBT and CT rates are added. Second, the deduction of the LBT liabilities from the tax base has to be taken into account. The effective (statutory) marginal tax rate[9] for corporate firms, τ^{corp}_{EMTR}, from 1998 to 2007, is

$$\tau^{corp}_{EMTR} = \frac{\tau_{CT} \cdot (1 + soli) + \tau_{fed} \cdot cr}{1 + \tau_{fed} \cdot cr}.$$

Since 2008 the denominator is 1, as the LBT cannot be deducted from the tax base anymore. Assuming a collection rate of 350%, the average EMTR decreased from 0.55 in 1998 to 0.28 in 2008 with an average value of 0.41 over the whole sample period. For a collection rate of 250% (450%) the average τ^{corp}_{EMTR} is 0.38 (0.43).

2.2 Wage bargaining in Germany

As our theoretical and empirical analysis takes into account collective bargaining, we briefly sketch the situation of labor unions in Germany. Traditionally, German labor unions have been influential. Collective bargaining agreements (CBAs) at the industry-level are the most important bargaining mechanism for wage determination. Nevertheless, there has been a significant decline in bargaining coverage. In West (East) Germany, the total proportion of employees covered by CBA decreased from 76% (63%) in 1998 to 65% (51%) in 2009; the share of workers covered by

[8] In 2004 a legally required minimum collection rate of 200% was introduced which affected very few municipalities and was mainly targeted at those with rates of (close to) zero

[9] Note that this is an effective *statutory* marginal tax rate, as opposed to more conventional measures of the effective marginal tax rate which include tax base parameters.

sectoral agreements fell from 68% (52%) to 56% (38%) (Ellguth et al., 2012). Firms may pay wages in excess of wages stipulated in CBAs (*Günstigkeitsprinzip*). If they want to pay lower wages, in contrast, opening clauses negotiated between unions and firms are required. Effectively, there is a number of cases where bargaining takes place at the firm level. This applies in the case of wage payments in excess of CBAs, opening clauses or company agreements (*Firmentarifvertrag*). Some employers are not at all covered by a CBA and can completely rely on individual contracts with each employee. Note that with a few exceptions there is no legal minimum wage in Germany. However, the social security and welfare system provides an implicit minimum wage and CBAs ensure that wages are above a certain level (*Lohnabstandsgebot*). The average duration of a CBA increased from 12 months in 1991 to 22 months in 2011.[10] Usually, negotiations take place in the first half of a year.

3 Theoretical framework

Consider an economy which consists of n jurisdictions. There are many firms in each jurisdiction. Firms use the following factors of production: capital (K), which is homogeneous, and workers with differing skill levels. There are 2 skill levels. Labor of skill type k, $k = 1, 2$, is denoted by L^k. The production function $F(K, L^1, L^2)$ may differ across firms but is assumed to have the usual neoclassical properties and exhibits declining returns to scale in capital and labor, i.e. there is an implicit fourth factor, which can be thought of as a location specific rent. Capital and both types of labor are mobile across municipal borders. This is a strong assumption when it comes to labor mobility within a large country. However, within a labor market region that may include a fairly large number of jurisdictions (in Germany there are on average 44 municipalities per labor market region), it is plausible that employees are mobile – at least at the margin. Firms are immobile, due to the location specific rent. While this might seem a strong assumption, we observe only few firms changing municipality in our data.

Firm profits are taxed by the individual jurisdictions and by the central government. The rate of the local profit tax in jurisdiction i is denoted by θ_i; the rate of the profit tax levied by the central government is denoted by T. Both taxes

[10] In the chemical industry, for instance, the CBA was renewed in 2002, 2003, 2004, 2005, 2007, 2008, 2010, 2011, while in the steel industry new collective agreements were negotiated in 2002, 2003, 2005, 2006, 2008, 2009, 2010. The firm-level CBA of Volkswagen was renewed in 2002, 2004, 2006, 2007, 2009, 2010, 2011. See the WSI Collective Agreement Archive for more information `http://www.boeckler.de/wsi-tarifarchiv_39335.htm`).

have the same base, apart from the fact that the local tax is deductible from the base of the profit tax levied by the central government. The after tax profit of the representative firm located in jurisdiction i is given by

$$P_i = [F_i(K_i, L_i^1, L_i^2) - \sum_{k=1}^{2} w_i^k L_i^k](1 - \tau_i) - (1 - \alpha\tau_i)rK_i, \tag{1}$$

where w_i^k is the wage for labor of skill type k, $\tau_i = T + \theta_i(1 - T)$ is the effective statutory tax rate on profits and r is the non-tax cost of capital.[11] The variable α is the share of the capital costs which can be deducted from the tax base. In line with most existing tax systems, we assume $0 < \alpha < 1$, which implies that capital costs are partly but not fully deductible ($\alpha = 0.5$ in Germany).

Firms operate under conditions of perfect competition in output and input markets, with the exception of the labor market. There is a dual labor market with two types of firms. In the first type, workers are represented by trade unions and wages are set via bargaining. In the second type, no unions exist and wage setting is competitive. To simplify notation we normalize the number of firms per type and jurisdiction to unity. In unionized firms wages are set according to a standard efficient bargaining model, where unions and firms bargain over wages and employment.[12] Each skill type is represented by one trade union.[13] Bargaining takes place either at the firm level or at the sector level.

3.1 Firm level bargaining

We start by assuming that bargaining takes place at the firm level. Each firm negotiates with all unions simultaneously (Barth and Zweimüller, 1995). The objective function of the union representing the workers of skill type k in firm i is given by

$$Z_i^k = L_i^k w_i^k.$$

The reservation wage for workers in unionized firms is $\overline{w}^k$, the wage rate of skill group k in the competitive labor market. Therefore the fall back utility of the union

[11] If firms operate in more than one jurisdiction the local tax in Germany is determined through formula apportionment. This has implications for the incidence of the tax. We analyze this case theoretically in Appendix A. In our empirical analysis of incidence effects we find no significant differences between multi and single-establishment firms.

[12] It is straightforward to show that our key results regarding the incidence of the profit tax on wages would be very similar if we used a model where unions and firms only bargain over wages (see, e.g., Oswald, 1993).

[13] Assuming that there is one union which represents all skill levels would lead to the same qualitative results regarding the impact of corporate tax changes.

is $\overline{Z}_i^k = L_i^k \overline{w}^k$. We assume that the reservation profit of the firm is equal to zero.[14]

After wages and employment levels are determined, firms set K_i to maximize profits, which implies

$$\frac{\partial F_i(K_i, L_i^1, L_i^2)}{\partial K_i} = R_i, \tag{2}$$

where R_i denotes the cost of capital, which is given by

$$R_i = r\frac{(1-\alpha\tau_i)}{(1-\tau_i)}.$$

The outcome of the wage bargaining process is given by

$$w_i^{k*}, L_i^{k*} = \arg\max_{w_i^k, L_i^k} \Omega_i^k,$$

where

$$\Omega_i^k = \beta^k \ln(Z_i^k - \overline{Z}_i^k) + (1-\beta^k)\ln P_i.$$

The parameter $\beta^k \in (0,1)$ stands for the relative bargaining power of skill type k union. The first order conditions of the bargaining problem can be rearranged to yield

$$w_i^{k*} = \overline{w}^k + \frac{\beta^k}{(1-\beta^k)}\frac{P_i}{L_i^k(1-\tau_i)} \tag{3}$$

and

$$\frac{\partial F(K_i, L_i^1, L_i^2)}{\partial L_i^k} = \overline{w}^k \quad k = 1, 2. \tag{4}$$

The equilibrium wage rate in unionized firms is equal to the skill specific reservation wage plus a share of the firm's profit per worker. The size of this share depends on the bargaining power of the trade union. Employment is set so that the marginal productivity of labor is equal to the reservation wage.

The focus of our analysis is how changes in local profit taxes affect wages. We distinguish between two channels through which taxes affect wages. Following Arulampalam et al. (2012), we refer to the first channel as the direct impact. Through wage bargaining workers receive part of the profits generated by the firm. If higher taxes reduce these profits, this will affect wages for given levels of capital and labor inputs. The second channel, referred to as the indirect channel, is the change in wages caused by the adjustment of *other* input factors or input prices as a reaction to the change in tax. To define the two effects more precisely in our model, we can

[14] An alternative assumption would be that the other skill groups work and receive their wages and that output and investment would be lower than in the case of agreement. This would add notation without changing the signs of the results derived below.

solve equation (3) for the equilibrium wage rate of skill type k:

$$w_i^{k*} = \frac{1}{(1-\beta^k\beta^j)L_i^k}[\overline{w}_i^k(1-\beta^k)L_i^k - \overline{w}_i^j(1-\beta^j)\beta^k L_i^j + (1-\beta^j)\beta^k\left(F_i(K_i, L_i^1, L_i^2) - R_iK_i\right)], \quad k \neq j. \tag{5}$$

Equation (5) is the focus of our interest. Note first that equations (2) and (4) define the factor demand equations as functions of the skill specific reservation wages and the cost of capital, $K_i(R_i, \overline{w}_i^1, \overline{w}_i^2)$, $L_i^1(R_i, \overline{w}_i^1, \overline{w}_i^2)$, $L_i^2(R_i, \overline{w}_i^1, \overline{w}_i^2)$. Given this, equation (5) defines the wage rate of skill group k as a function of the cost of capital, the firm's factor inputs and a number of other variables like relative bargaining power, i.e. $w_i^{k*} = w_i^{k*}(\tau_i, K_i(R_i, \overline{w}_i^1, \overline{w}_i^2), L_i^k(R_i, \overline{w}_i^1, \overline{w}_i^2), L_i^j(R_i, \overline{w}_i^1, \overline{w}_i^2), ...)$. Differentiating (5) with respect to τ_i allows us to express the overall effect of a change in τ_i on w_i^{k*} as

$$\frac{\partial w_i^{k*}}{\partial \tau_i} = -\frac{(1-\beta^j)\beta^k}{(1-\beta^k\beta^j)}\frac{K_i}{L_i^k}\frac{\partial R_i}{\partial \tau_i} - \frac{(w_i^{k*}-\overline{w}^k)}{L_i^k}\frac{\partial L_i^k}{\partial R_i}\frac{\partial R_i}{\partial \tau_i} - \frac{\overline{w}_i^j(1-\beta^j)\beta^k}{(1-\beta^k\beta^j)L_i^k}\frac{\partial L_i^j}{\partial R_i}\frac{\partial R_i}{\partial \tau_i}, \quad k \neq j \tag{6}$$

This overall effect can be expressed as the sum of a direct and an indirect effect:

$$\frac{\partial w_i^{k*}}{\partial \tau_i} = \textit{direct effect} + \textit{indirect effect}$$

where

$$\textit{direct effect} \equiv -\frac{(1-\beta^j)\beta^k}{(1-\beta^k\beta^j)}\frac{K_i}{L_i^k}\frac{\partial R_i}{\partial \tau_i} < 0; \tag{7}$$

$$\textit{indirect effect} \equiv -\left(\frac{(w_i^{k*}-\overline{w}^k)}{L_i^k}\frac{\partial L_i^k}{\partial R_i} + \frac{\overline{w}_i^j(1-\beta^j)\beta^k}{(1-\beta^k\beta^j)L_i^k}\frac{\partial L_i^j}{\partial R_i}\right)\frac{\partial R_i}{\partial \tau_i} \gtreqless 0, \tag{8}$$

with

$$\frac{\partial R_i}{\partial \tau_i} = r\frac{(1-\alpha)}{(1-\tau_i)^2} > 0.$$

The direct effect is unambiguously negative. The reason is that an increase in the tax rate reduces the quasi rent generated by the firm. Since unions capture part of this rent, workers lose if this rent becomes smaller. The magnitude of the direct effect is increasing in the bargaining power of the skill group β^k. This means that skill groups with a lot of bargaining power are more likely to bear a larger burden of profit taxes. Again the explanation is that these groups capture a higher share of the rent in the first place.

The sign of the indirect effect is in general ambiguous. Interestingly, the change in investment caused by the tax change has no (immediate) effect on the wage. The explanation is straightforward. It follows from equations (2) and (5) that, if the firm is at its profit maximizing investment level, $\frac{\partial w_i^{k*}}{\partial K_i} = 0$. A marginal change in investment does not change the profit generated by the firm so that the equilibrium wage, which is a share of this rent, does not change either. However, a change in investment will affect employment. Likewise a marginal change in employment does not change the overall rent either, but it does affect the rent per worker. Therefore the sign of the indirect effect in this model only depends on how a change in corporate taxes affects the number of workers in the skill group. How exactly the number of high and low-skilled workers is affected depends on the properties of the production function including the complementarity between high and low-skilled labor and capital, as we show in Appendix A.[15] For our empirical analysis one should bear in mind that, according to the theory, the indirect effect is transmitted through adjustment in employment, not investment.

These findings may be summarized as:

Result 1: *Direct effect*: For given factor input levels, an increase in the corporate tax rate reduces the wage rate of all skill groups in unionized firms.

Result 2: *Indirect effect*: The indirect effect of a corporate tax change on wages may be positive or negative.

3.2 Sector level bargaining

The effects of corporate tax changes on wages may not only differ across skill groups but also across firms with different characteristics. One important difference between firms is that wage bargaining institutions may differ. So far we have assumed that bargaining takes place at the firm level. In many countries including Germany, wage bargaining can also take place at the sectoral level. In this case, if firms in a sector are located in many different municipalities, one would expect that the impact of a change in the local corporate tax in one municipality has a small or possibly negligible effect on the wage rate.

We model wage negotiations at the sector level as follows. Assume that $m < n$ unionized firms in the economy belong to one sector. Wages for each skill group are

[15] For instance, if all factors of production are complements, i.e. $\frac{\partial^2 F}{\partial L^k \partial K}, \frac{\partial^2 F}{\partial L^k \partial L^j} > 0$, $k = 1, 2, k \neq j$, an increase in the corporate tax rate unambiguously reduces demand for both types of labor. But if some factors are substitutes results may be different.

identical in all firms, and the objective function of the union is given by $\sum_{i=1}^{m} Z_i^k = \sum_{i=1}^{m} L_i^k w^k$. It is not quite clear what bargaining over employment means at the sector level. In the following we assume that employer associations and unions bargain over employment in each individual firm. This means that the result of the bargaining process is a uniform wage for all workers of skill level k in a sector and a vector of employment levels $L_1^k, ..., L_m^k$.[16] Firms pursue the objective to maximize the sum of their profits $\sum_{i=1}^{m} P_i$. The derivation of equilibrium employment levels and wages for the two skill groups is equivalent to the derivation described in the preceding section. The equilibrium wage rate for skill group k is now given by

$$w^{ks*} = \frac{\Theta}{(1-\beta^k\beta^j)\sum_{i=1}^{m}[L_i^k(1-\tau_i)]} \qquad k \neq j, \tag{9}$$

where

$$\begin{aligned}\Theta = {} & \overline{w}^k(1-\beta^k)\sum_{i=1}^{m}[L_i^k(1-\tau_i)] - \overline{w}^j(1-\beta^j)\beta^k\sum_{i=1}^{m}[L_i^j(1-\tau_i)] \\ & + (1-\beta^j)\beta^k\left(\sum_{i=1}^{m}[(F_i(K_i, L_i^1, L_i^2)(1-\tau_i) - (1-\alpha\tau_i)rK_i)]\right)\end{aligned} \tag{10}$$

It is straightforward to show that, as soon as at least two firms in a sector are located in different jurisdictions, the direct effect of a tax change on union wages in the jurisdiction where the tax change takes place is smaller in magnitude than in the case of firm level bargaining. We give the formal proof in Appendix A. The result is intuitive - wage bargaining will be influenced by taxes in all jurisdictions where the sector has a presence so that a tax change in just one jurisdiction has a limited impact. The indirect effect is not necessarily smaller because different firms may have different production functions so that their input demand may react differently to corporate tax changes. This can be summarized as

Result 3: The direct effect of a change in the local corporate tax rate on wages in unionized firms is smaller under sector level bargaining, compared to firm level bargaining.

Note that Results 1 and 2 still hold under sector level bargaining.

[16] An earlier version of this paper used the seniority model of wage bargaining (Oswald, 1993), where unions are dominated by workers who are interested in higher wages but not in the level of employment. In this framework the issue of bargaining over employment at the sector level does not arise. This model yields similar results in terms of the level of collective bargaining.

3.3 Corporate tax incidence in the competitive sector

Consider finally the firms in the competitive sector. Since capital and both types of labor are mobile across jurisdictional borders, competitive wages are determined in the national labor market. Since each municipality is small, relative to the economy as a whole, a change in the local tax rate will leave wages in the competitive sector unchanged. The tax change will affect factor inputs but not factor prices (Siegloch, 2013). This may be stated as

Result 4: In firms without union bargaining, the direct and indirect effect of a change in the local corporate tax rate on wages is equal to zero.

Clearly, this result is specific to local corporate tax incidence. Given that labor mobility across national borders is typically low, the incidence of a nationwide corporate tax would be different.

4 Data

For our analysis we combine two distinct data sources: administrative data on the universe of German municipalities containing information on their fiscal and budgetary situation (Section 4.1), and detailed administrative linked employer-employee data from social security records (Section 4.2).

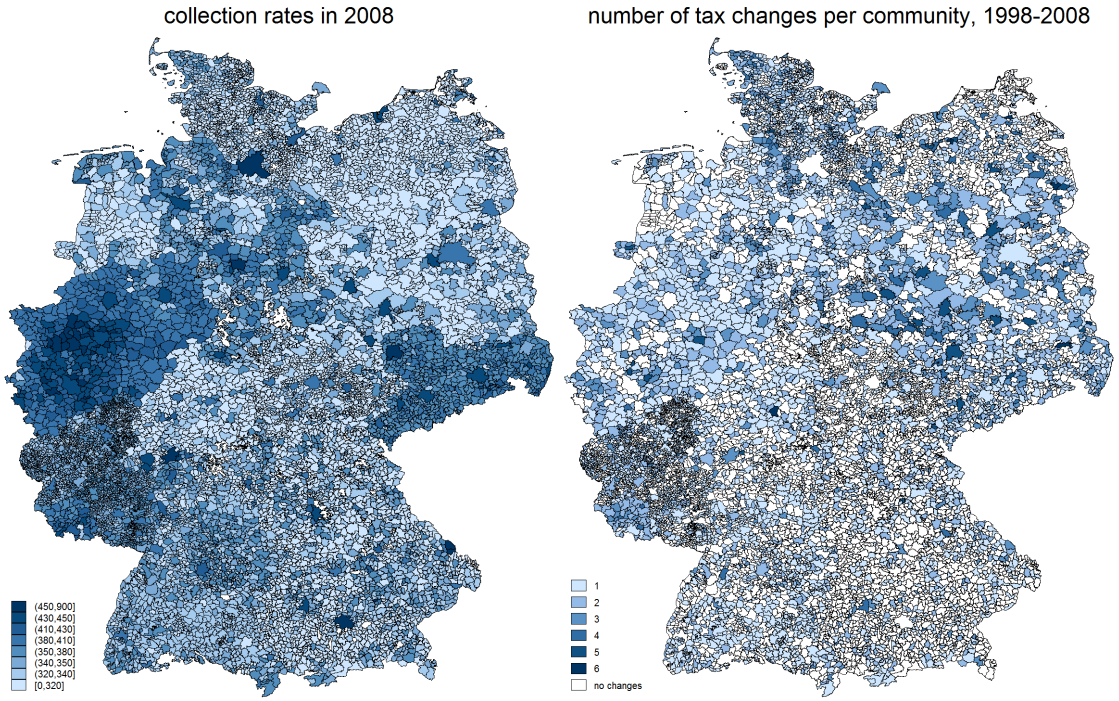
4.1 Municipality data

As far as municipal data are concerned, we make use of statistics provided by the Statistical Offices of the 16 German federal states (*Statistische Landesämter*). The states collect information on the fiscal and budgetary situation of all municipalities. We combine and harmonize the annual state specific datasets and construct a panel on the universe of all municipalities from 1998 to 2008 covering roughly 125,000 data points – i.e. municipality-years. Most importantly, the dataset contains information on the local collection rate, but also on the population size and municipal expenses and revenues. Moreover, we add data from the German federal employment agency on regional unemployment rates on the more aggregate county (*Kreis*) level to control for local labor market conditions. As all these regional factors have been found to affect LBT rates (Büttner, 2003), it is important to control for them in the empirical analysis below.

Figure 1 depicts Germany's 11,441 municipalities and visualizes the substantial cross-sectional and time variation in collection rates. While the left panel of the

figure shows the cross-sectional variation in local tax rates in 2008 with darker colors showing higher tax rates, the right panel shows the number of tax changes a municipality has experienced during the observation period 1998-2008 with darker colors indicating more changes.

Figure 1: Cross-sectional and time variation in collection rates



Source: Statistical Offices of the Länder

We now take a closer look at the within-municipality time variation of the collection rates, which is later used to identify the tax effect on wages. Table 1 shows that on average 8% of the municipalities (i.e. about 1,000 municipalities) change their collection rate per year. Most municipalities increase collection rates over time and most of the increases in collection rates occurred between 2000 and 2006. The average increase amounts to 21 points corresponding to 6% of the mean collection rate. Next, Table 2 shows that the changes in collection rates are not concentrated among a few communities but rather widespread. More than half of the communities have changed their tax rates at least once during the observation period. Furthermore, one third of the communities were affected at least by one big tax change, defined as a change equal to or greater than the mean change of 21 points. The average big change was 31 points (8.9%).

Table 1: Share of communities with changing collection rates (in %)

	$\Delta\tau \neq 0$	$\Delta\tau > 0$	$\Delta\tau < 0$
Total	8.1	7.2	0.9
1999	5.4	4.3	1.1
2000	8.4	7.4	1.0
2001	12.7	11.5	1.3
2002	8.6	7.9	0.7
2003	9.8	9.1	0.8
2004	8.8	8.2	0.6
2005	11.0	10.4	0.7
2006	7.8	7.0	0.8
2007	4.4	3.7	0.8
2008	4.0	3.2	0.8

Source: Statistical Offices of the Länder. *Note:* N=11,441 per year.

Table 2: Number of tax changes per community, 1998-2008

	any change		big change	
# changes	# municipalities	in %	# municipalities	in %
0	4977	43.50	7575	66.21
1	4376	38.25	3376	29.51
2	1552	13.57	430	3.76
3	402	3.51	57	0.50
4	96	0.84	2	0.02
5	32	0.28	1	0.01
6	6	0.05	0	0.00

Source: Statistical Offices of the Länder. *Note:* The average increase is 21 points (6%). A big change is defined as an increase of more than 21 points. The average big change is 31 points (8.9%).

4.2 Worker and firm data

We combine the administrative municipal data with the linked employer-employee dataset (LIAB) provided by the Institute of Employment Research (IAB) in Nuremberg, Germany (Alda et al., 2005). The employee data are a 2% sample of the administrative employment statistics of the German Federal Employment Agency (*Bundesagentur für Arbeit*), called the German employment register, which covers all employees paying social security contributions or receiving unemployment benefits (Bender et al., 2000). Note that civil servants and self-employed individuals are not observed in the social security data. The employee information are recorded on June 30th of each year and include information on wages, age, tenure, occupation, employment type (full-time or part-time employment) and qualification. Individuals with missing information are excluded. Our worker panel consists of between 1.6 and 2.0 million workers annually observed from 1998 to 2008.

Importantly, wages are right censored at the ceiling for the social security contributions. Although the ceiling is quite high with annual labor earnings of 63,400 euros in 2008 for Western Germany, more than 10% of the observations are censored. In principle, there are two ways to deal with this problem: impute the censored wages or exclude the observations. We opt for the latter and exclude all workers from the baseline sample which have at least once earned a wage above the contribution ceiling during the observation period. There are two reasons for this rigorous treatment, which particularly affects high-skilled workers.[17] First, as we will argue below, the estimated wage effect is a lower bound. Second, given that the imputation method cannot replicate the true data generating process, imputing parts of the wages creates an artificial variation in the left-hand side variable, which might lead to biased conclusions. In fact, if corporate taxes do affect wages, one must control for them in the imputation stage and would create endogeneity per definition. We check the sensitivity of our results with respect to the treatment of censored wages and find large differences in the results for high-skilled workers.

The firm component of the LIAB is the IAB Establishment Panel (Kölling, 2000), which is a stratified random sample of all German establishments. The term establishment refers to the fact that the observational unit is the individual plant, not the firm; there can be several plants per firm. The employer data covers

[17] We differentiate between three skill groups: high-skilled workers have obtained a college/university degree; medium-skilled have either completed a vocational training or obtained the highest high school diploma (*Abitur*); low-skilled have neither completed a vocational training nor obtained the *Abitur*.

establishments with at least one worker for whom social insurance contributions were paid. We extract the following variables: value added, investment, number of employees, industry, total wage bill, legal form, union wage status (industry, firm or no collective agreement), self-rated profitability[18], presence of a work council.

Sample selection and descriptive statistics. We restrict our baseline sample to full-time workers in corporate firms in the manufacturing industry liable to the LBT. We exclude part-time and marginally employed workers to rule out adjustments at different margins (notably hours of work) and solely focus on the wage effect. As stated above, we exclude all workers that have at least once earned a wage above the contribution ceiling during the observation period – we check the sensitivity of the results with respect to this assumption below. As far as firm characteristics are concerned, the choice of focusing on firms that are liable to the LBT is obvious – yet we use non-liable firms for a placebo test below. We further narrow the baseline sample to corporate firms since the effective statutory marginal tax rate for non-corporate firms cannot be calculated given the information in the LIAB. Nevertheless, we estimate the wage incidence for non-corporate firms as a sensitivity check, making assumptions on the personal income tax rate. Last, we focus on manufacturing firms, which are the backbone of the German economy and make up the largest share of the corporate firm sample (66%). Again, we present effects for other industries as an extension.

Table 3 shows descriptive statistics of the baseline sample. The average monthly wage in our sample is 3,171 euros (all money variables are in 2008 euros). Wages are increasing in qualification. The average age is 41, the average firm specific tenure 11 years. Men are over-represented. The share of high-skilled workers is very low due to the strict treatment of censored wages (the share in the whole sample is 14%). At the same time, low-skilled are over-represented compared to the full sample (20% vs. 14%). The average firm in the sample has 341 employees with an annual value added of 38.8 million euros. Of all firms 46% (11%) have a sector (firm) level collective bargaining agreement in place, while 29% of the plants are part of a multi-establishment company. The average plant is located in a municipality with 27,200 inhabitants, a regional unemployment rate of 12% and collection rate of 348%.

[18] The survey question asks for a self-assessment of the profit situation on a five-point scale ranging from very good to unsatisfactory. We dichotomize the variable into good and poor profitability.

Table 3: Descriptive statistics, baseline sample, LIAB 1998-2008

	mean	sd	min	max	N
monthly wage	3171	813	421	5510	4016476
high-skilled wage	3736	867	441	5509	143565
medium-skilled wage	3213	820	421	5509	3062917
low-skilled wage	2913	685	466	5510	809994
age	41	10	16	64	4016476
tenure	11	8	0	34	4016476
share: male	0.81	0.39	0	1	4016476
share: blue collar	0.83	0.37	0	1	4016476
employees (fulltime)	341	1637	1	48826	14379
annual value added (in 1000)	38845	230549	9	10570000	14379
annual investments (in 1000)	4336	31867	0	1755000	14379
share: sector union contract	0.46	0.50	0	1	14379
share: firm union contract	0.11	0.31	0	1	14379
share: no union contract	0.44	0.50	0	1	14379
share: stand alone plant	0.71	0.45	0	1	14379
share: part of multi-plant firm	0.29	0.45	0	1	14379
collection rate (in %)	348	42	150	520	6753
population (in 1000)	27.19	115.49	0	3426	6753
local unemp. rate	0.12	0.06	0	0	6753
municipal revenues (in millions)	48.24	199.97	4	4416	6753
municipal expenses (in millions)	43.42	194.82	4	5971	6753

Source: LIAB and Statistical Offices of the Länder. *Note:* All money variables in 2008 euros.

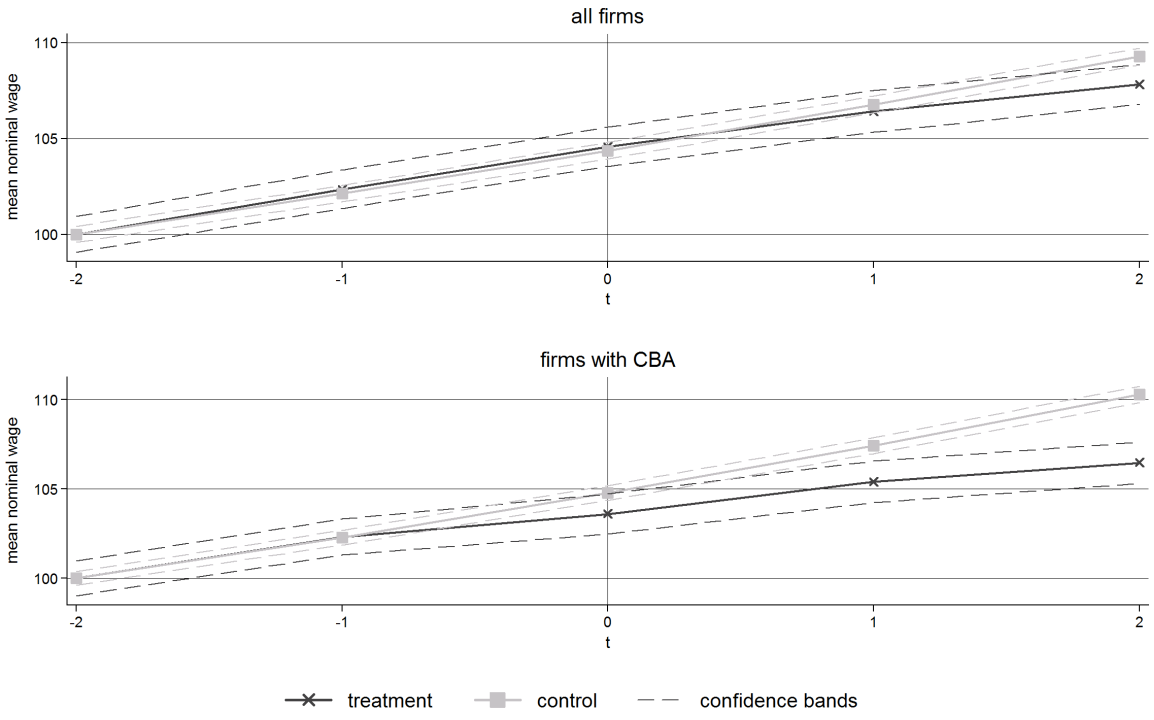
5 Empirical results

In the following section, we estimate the incidence of corporate taxation on wages. We start off by providing non-parametric evidence using an event study design (Section 5.1). Section 5.2 presents the regression model. In Section 5.3 we analyze the direct wage effect and address potential identification challenges. In Section 5.4 we estimate the full wage effect including the indirect effect and find that the latter is negligible in the context of the German local business tax. Consequently, we further explore the direct effect, testing for heterogeneous worker (Section 5.5) and firm effects (Section 5.6).

5.1 Event study

As a first check we provide a non-parametric test whether corporate taxes affect wages using an event study design. We average wages at the municipal level and look at differences in the wage growth rates between municipalities that have changed the tax rate and municipalities that have not. We assign municipalities to treatment and control group according to the following criteria: a municipality is *treated* if a tax *increase* occurred at the beginning of year t and no tax changes happened in years $t-2, t-1, t+1, t+2$. Conversely, a municipality is assigned to the *control* group if no tax change occurred from year $t-2$ to $t+2$. We thus analyze five-year spells of nominal wage growth around a change in the LBT occurring in year t. In the upper panel of Figure 2 all firm types are used to calculate average wages; in the lower part only firms with collective bargaining agreements are considered.

Figure 2: Mean change in wages in %



Source: LIAB. Note: Tax reform occurred for treatment group in year t=0. No other tax changes in any other period, neither for control nor treatment group. Wages are normalized to 100 in pre-reform year t = -2.

The figure clearly shows that there is a negative effect of profit taxation on wages, but – in line with the theory – we only find a significant effect for firms with collective bargaining agreements (confidence intervals are bootstrapped using 200 draws). In t, i.e. the year of the tax change, the wage growth path of treated firms with CBAs becomes flatter, while the path for the control group is not affected.

In period $t+1$ the growth path for the treated lies significantly below the one for the control group. Note that in both panels of Figure 2 wage growth paths are identical until period $t-1$, which indicates that the common trend assumption holds. Translating the graphical evidence to numbers, we find that the wage growth for CBA firms from year $t-1$ to year $t+1$ in the control (treatment) group is 6.14% (3.09%). The average increase in the EMTR in period t is 1.3%. Taking average values for pre-tax profits and the total wage bill, this implies a wage bill incidence of -77 cents for a 1 euro increase in the tax bill.

5.2 Empirical model

We estimate a Mincerian wage equation using the log monthly wage of individual i in firm f, municipality m and year t, $\ln(w_{ifm,t})$, as dependent variable. The independent variable of interest is the collection rate of municipality m, $\ln(cr_{m,t})$. We further include three sets of control variables on the worker, firm and municipality level. Controls on the worker level are captured by vector $\mathbf{X}_{i,t}$ and include age and firm specific tenure (both in quadratic forms). On the firm level, vector $\mathbf{Y}_{f,t}$ controls for the number of employees, value added, investment, full-time hours (all in logs), skill shares of the workforce, and a work council dummy. Municipality controls are denoted by $\mathbf{Z}_{m,t}$ and comprise the population size, the property tax rate, total revenues and expenses (in logs) as well as the local unemployment rate (on the county level). In addition, we control for a large set of potential confounding wage trends by including skill-year, occupation-year (blue/white collar), firm size-year, collective agreement type-year as well as state-year fixed effects (all trends are summarized in vector $\mathbf{T}_{ifm,t}$). Furthermore, we include four kinds of fixed effects: person, firm, municipal and year $(\mu_i, \mu_f, \mu_m, \mu_t)$. The baseline model thus reads

$$\begin{aligned} \ln w_{ifm,t} = \quad & \alpha_{t-l} \ln \tau_{m,t-l} + \boldsymbol{\beta} \mathbf{X'}_{i,t} + \boldsymbol{\gamma} \mathbf{Y'}_{f,t} + \boldsymbol{\lambda} \mathbf{Z'}_{m,t} + \\ & \boldsymbol{T_{ifm,t}} + \mu_i + \mu_f + \mu_m + \mu_t + \varepsilon_{ifm,t}, \end{aligned} \tag{11}$$

where the error term $\varepsilon_{ifm,t}$ is clustered at the county level.

The year fixed effects account for changes in the tax base and for changes in the federal rates of the LBT and the corporate tax. By including person, firm and municipal fixed effects, we wipe out any time-invariant confounding factor on these levels, such as unobserved worker or management ability, or geographical location. Technically, we apply the spell fixed-effects estimator suggested by Andrews et al. (2006) by time-demeaning within each unique worker-firm-municipality combina-

tion.[19] We manually add the time-trend dummies included in vector $\mathbf{T}_{ifm,t}$.

While the regression equation (11) could imply that the simultaneity between wages and tax rates biases our estimates, a closer look at the timing of events reveals that reverse causality should not be an issue. The city council of municipality m usually sets the collection rate for year t in the last three months of year $t-1$. In the LIAB, wages are measured as of June 30th of year t. So when regressing wages in t on collection rates in t, there is already a lag of 7 to 9 months, which should mitigate reverse causality concerns. Nevertheless, our estimates might suffer from endogeneity if there are unobserved local shocks that affect both tax rates and wages. We will address this issue below using different approaches.

5.3 Direct wage effect

Table 4 presents the baseline results for the direct wage effect. We thus regress log wages on log collection rates conditional on the number of employees, investment and output. In the first specification we include all firm types – with and without a CBA in place. We find a significant and negative coefficient: an increase in the local collection rate by 1%, leads to a decrease of the average wage in a firm by 0.076%. As this estimate is not easy to interpret, we translate the log-log coefficient into two more intuitive measures, a wage elasticity and an incidence measure. While the wage elasticity measures the percent change in wages of a one percent increase of the (statutory) EMTR, the incidence reports the euro change of the annual wage bill – for given employment levels – as a response to a one euro increase of the annual tax liabilities. We report the two measures at the bottom of Table 4. For specification (1) we find a wage elasticity of -0.31 and an incidence of -44 cents. Note that results are similar when using the collection rate in levels instead of logs (see Table B.1 in Appendix B). In the second and third specification we estimate our model separately for firms with and without a CBA. We only find a significant direct wage effect for workers in firms with a CBA (elasticity of -0.38; incidence of -53 cents). This is in line with the theoretical model, as the direct effect arises due a shock to the rents in a wage bargaining framework. Theoretically there cannot be a direct effect in firms without a CBA which is empirically confirmed in specification (3). We thus exclude firms without a CBA from the sample when further investigating the direct wage effect and refer to specification (2) as our baseline estimates.

[19] Note that only a few establishments change location, so in practice the firm dummies are collinear with the municipality dummies and the model is almost identical to a two-way fixed effects model.

Table 4: Direct effect on log wages: baseline results

Model	(1)	(2)	(3)	(4)	(5)
Firm type	All	With CBA	Without CBA	With CBA	
log collection rate$_t$	-0.076**	-0.093**	0.024		-0.098**
	(0.036)	(0.045)	(0.031)		(0.048)
log collection rate$_t$: sector level				-0.092**	
				(0.045)	
log collection rate$_t$: firm level				-0.094*	
				(0.055)	
log collection rate$_{t-1}$					-0.019
					(0.034)
log value added	0.004***	0.004**	0.008***	0.004**	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
log investment	0.000	-0.000	0.004***	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
log employees	0.038***	0.032***	0.073***	0.032***	0.033***
	(0.008)	(0.009)	(0.009)	(0.009)	(0.010)
log full-time hours	0.031	0.033	0.013	0.033	0.035
	(0.037)	(0.040)	(0.071)	(0.040)	(0.040)
work council	0.006**	0.006**	0.002	0.006**	0.007*
	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)
share high-skilled employees	-0.000	0.002	-0.051	0.002	0.001
	(0.051)	(0.058)	(0.045)	(0.058)	(0.061)
share medium-skilled employees	-0.008	-0.020	-0.020	-0.020	-0.023
	(0.036)	(0.048)	(0.020)	(0.048)	(0.052)
local unemp. rate	-0.061	-0.026	-0.106	-0.026	0.043
	(0.124)	(0.145)	(0.116)	(0.145)	(0.155)
community population	0.083	0.106*	-0.119	0.106*	0.137**
	(0.053)	(0.062)	(0.088)	(0.062)	(0.066)
log expenses	-0.010*	-0.013**	0.008	-0.013**	-0.013*
	(0.006)	(0.007)	(0.006)	(0.007)	(0.007)
log revenues	0.013**	0.017**	0.003	0.017**	0.019***
	(0.006)	(0.007)	(0.004)	(0.007)	(0.007)
local property tax rate	-0.060*	-0.079**	0.068***	-0.079**	-0.087**
	(0.032)	(0.037)	(0.025)	(0.037)	(0.038)
Adjusted R^2	0.186	0.198	0.142	0.198	0.181
Observations	4016476	3512491	503985	3512491	3204780
Groups	1240030	1085873	210230	1085873	1014992
Clusters	405	395	351	395	395
Long run effect					-0.118**
Wage elasticity	-0.31	-0.38	0.09		-0.46
Wage elasticity: sector level				-0.39	
Wage elasticity: firm level				-0.35	
Euro incidence	-0.44	-0.53	0.12		-0.67
Euro incidence: sector level				-0.49	
Euro incidence: firm level				-0.62	

Note: All specifications include person, firm, municipal and year fixed effects as well as: skill-year, occupation-year, firm size-year, CBA type-year, state-year fixed effects. Standard errors (in parentheses) clustered at county level. Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).

Interacting the collection rate with dummies for sector level vs. firm level bargaining reveals that there is hardly any difference when it comes to point estimates and wage elasticities (model (4)). Despite this similarity there is quite a large difference in terms of the euro incidence between firms with the two CBA-types. As predicted by the theoretical model, we find that the wage incidence is 27% higher (13 cents) in firms where the bargaining takes place at the firm level compared to firms with a sector level CBA.[20]

Next, we check the timing of the wage effect. As stated above, the implicit lag of the collection rate in the baseline specification (regressing $\ln(w_{ifm,t})$ on $\ln(cr_{m,t})$) is 7 to 9 months. Nevertheless, it might be the case that some firms are not able to adjust wages that quickly given that the average duration of a collective bargaining agreement in Germany is between one and two years (cf. Section 2). As a consequence we estimate a distributed lag model adding the collection rates in $t-1$. Thus, this model shows how CBA firms react to profit tax changes within 19 to 21 months. Results are shown in specification (5) of Table 4. Note that we report the long-run effect, which is calculated by adding the two coefficients for periods t and $t-1$ and testing the joint significance at the bottom of the table; the wage elasticity and incidence measure for specification (5) rely on this long-run effect. Intuitively, elasticities and incidence rise in absolute terms when comparing model (5) to model (3). Yet, the increase is rather small, which suggests that most of the wage adjustments take place within the first 9 months. Adding the collection rate of period $t-2$ does not change results (not reported).

Identification. As mentioned before, we interpret the German institutional setting as many quasi-experiments in a small open economy setting at the municipal level. Nonetheless, our analysis might be prone to endogeneity issues. We have argued above that reverse causality from wages to tax rates should not be an issue because of the timing of the events. In terms of omitted variable bias, it is impossible to find an instrument varying on the municipal level which would not be affected by the same unobserved local shock that affects both tax rates and wages.

Yet, we still have to rule out that our estimates are biased due to unobserved time-variant confounders.[21] There are two likely sources for this kind of confounding variation. First, any shock hitting the local labor market might affect simultane-

[20] The average wage in firms with a firm-level CBA is about 5% lower than in firms with a sector-level CBA.

[21] Table B.2 in Appendix B shows the importance of accounting for time-invariant confounders as omitting person fixed effects renders the tax coefficient insignificant.

ously the budget of municipalities and the (wage-setting) behavior of firms.[22] Thus, we add quadratic labor market region-trends to our baseline model to account for such potentially unobserved local labor market shocks.[23] Second, there might be shocks to certain industries and occupations, which should clearly affect the wages. As many industries (and thus occupations) are regionally clustered (Sternberg and Litzenberger, 2004), those shocks might also affect local taxation. While our baseline estimates already focus on the manufacturing industry, we go one step further and include job-year fixed effects to our model.[24] If industries and jobs are regionally clustered, the inclusion of these job-year fixed effects should take care of any such endogeneity problems.

Table 5 shows how adding quadratic labor market region-trends and job-year fixed effects influences the baseline estimates, which are shown in specification (1). Reassuringly, controlling for labor market region or job shocks does not change the direct wage effect much. Estimates decreases slightly but remain significant at the 10% level. Of course, statistical significance decreases as we take out more variation with these specifications. We now find a direct wage elasticity of -0.33 and an incidence of -0.46 cents. Overall, our results seem to be robust to time-varying confounders since it is unlikely that a potential confounder is neither correlated with labor market region nor job trends.

We provide a further identification test by running a placebo regression exploiting the fact that certain firms are not liable to the LBT. Most firms in the public sector are not liable as well as firms in the agricultural or mining industry. Moreover, there are special exemptions within the manufacturing sector and in other industries. Specification (4) of Table 5 presents the result of a placebo test confirming that the effect of the LBT on the wages in non-liable firms is zero.

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[22] Yet, the direction of the bias remains unclear. To see this, think of a local shock increasing unemployment. As a response, firms might be able to lower wages (or to increase them less). However, it is not clear whether municipalities will lower (to attract investment) or raise (to accommodate the higher welfare expenses) their local tax rates as a response to the shock.

[23] Labor market regions delineate independent economic areas around an economic center where the appendant areas are defined on commuter flows. In this paper, we follow the rather narrow labor market region definition of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (*Bundesinstitut für Bau-, Stadt- und Raumforschung*), which differentiates between 258 regions (see Eckey et al., 2006). Note that, due to 3.5 million observations (and remote access to the data), it is computationally not feasible to estimate the model with $258 \cdot 11$ region-year fixed effects. Hence we have to rely on a quadratic trend specification.

[24] We differentiate between 33 different jobs in addition to blue and white collar occupation.

Table 5: Effects on log wages: exogeneity tests

Model	(1)	(2)	(3)	(4)
Sample	Baseline			Placebo
log collection rate	-0.093**	-0.080*	-0.081*	-0.033
	(0.045)	(0.047)	(0.043)	(0.030)
log value added	0.004**	0.004*	0.004***	0.001
	(0.002)	(0.002)	(0.001)	(0.001)
log investment	-0.000	0.001	-0.000	0.001***
	(0.001)	(0.001)	(0.001)	(0.000)
log employees	0.032***	0.021**	0.031***	0.000
	(0.009)	(0.008)	(0.008)	(0.004)
log full-time hours	0.033	-0.027	0.037	0.040
	(0.040)	(0.038)	(0.041)	(0.044)
work council	0.006**	0.004	0.006**	-0.003
	(0.003)	(0.003)	(0.003)	(0.003)
share high-skilled employees	0.002	0.091*	-0.015	0.041
	(0.058)	(0.049)	(0.054)	(0.041)
share medium-skilled employees	-0.020	0.073*	-0.008	0.021
	(0.048)	(0.039)	(0.044)	(0.039)
local unemp. rate	-0.026	-0.185	-0.065	-0.159**
	(0.145)	(0.151)	(0.136)	(0.075)
community population	0.106*	-0.037	0.103*	0.114*
	(0.062)	(0.088)	(0.057)	(0.062)
log expenses	-0.013**	-0.011*	-0.012*	0.003
	(0.007)	(0.006)	(0.006)	(0.005)
log revenues	0.017**	0.010	0.016**	-0.006
	(0.007)	(0.007)	(0.006)	(0.005)
local property tax rate	-0.079**	-0.033	-0.072**	0.069***
	(0.037)	(0.035)	(0.036)	(0.025)
labor market region trends	No	Yes	No	No
job-year FE	No	No	Yes	No
Adjusted R^2	0.198	0.226	0.210	0.397
Observations	3512491	3512491	3512491	287206
Groups	1085873	1085873	1085873	113810
Clusters	395	395	395	368
Elasticity	-0.38	-0.33	-0.33	
Incidence	-0.53	-0.46	-0.46	

Note: All specifications include person, firm, municipal and year fixed effects as well as: skill-year, occupation-year, firm size-year, CBA type-year, state-year fixed effects. Standard errors (in parentheses) clustered at county level. Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).

5.4 The indirect wage effect

So far we have estimated the direct effect of corporate taxation on wages (*conditional* on output, investment and employment), which arises due to shocks to the overall rents in a collective bargaining context. The theoretical model in Section 3 also highlights an indirect effect of the LBT, which affects wages through lower investment and the complementarity between labor and capital. We have argued above that this classical Harberger-type general equilibrium effect should be small in the German context due to the regional mobility of labor across municipal borders.

We now take a closer look at this indirect wage effect by estimating the full wage effect of corporate taxation with the indirect effect being the difference between

the full and the direct effect. Given that factor input responses might take some time to unfold, we add the collection rates of period $t-1$ to the model. Specification (1) of Table 6 replicates the findings made above (specification (5) of Table 4): the direct wage incidence for firms with a CBA is 67 cents. In the following four specifications we estimate the full wage incidence of the LBT without conditioning on employment, investment and/or output. The absolute incidence increases slightly to 77 cents (specification (5)). Note that the estimate is similar to the one derived from the event study presented in Section 5.1.

Table 6: Full tax incidence on log wages

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Firm type	with CBA					without CBA				
log collection rate$_t$	-0.098**	-0.097**	-0.098**	-0.103**	-0.100**	0.016	0.017	0.014	0.005	0.003
	(0.048)	(0.047)	(0.048)	(0.048)	(0.047)	(0.033)	(0.033)	(0.033)	(0.036)	(0.037)
log collection rate$_{t-1}$	-0.019	-0.027	-0.019	-0.024	-0.035	0.038	0.038	0.043	0.004	0.005
	(0.034)	(0.035)	(0.034)	(0.034)	(0.036)	(0.030)	(0.031)	(0.031)	(0.031)	(0.033)
log value added	0.004**		0.004**	0.005***		0.008***		0.008***	0.011***	
	(0.002)		(0.002)	(0.001)		(0.002)		(0.002)	(0.002)	
log investment	-0.000	0.000		0.000		0.004***	0.004***		0.005***	
	(0.001)	(0.001)		(0.001)		(0.001)	(0.001)		(0.001)	
log employees	0.033***	0.036***	0.033***			0.073***	0.078***	0.076***		
	(0.010)	(0.009)	(0.009)			(0.009)	(0.009)	(0.009)		
log full-time hours	0.035	0.055	0.034			0.001	-0.003	-0.003		
	(0.040)	(0.036)	(0.039)			(0.074)	(0.073)	(0.075)		
work council	0.007*	0.008**	0.007*	0.004	0.005	0.003	0.003	0.002	0.004	0.005
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)
share high-skilled employees	0.001	0.012	-0.000	0.032	0.053	-0.037	-0.032	-0.035	-0.088*	-0.086*
	(0.061)	(0.061)	(0.061)	(0.060)	(0.065)	(0.048)	(0.049)	(0.048)	(0.049)	(0.050)
share medium-skilled employees	-0.023	-0.028	-0.023	-0.010	-0.020	-0.020	-0.016	-0.019	-0.049**	-0.043**
	(0.052)	(0.054)	(0.052)	(0.049)	(0.053)	(0.020)	(0.021)	(0.020)	(0.023)	(0.022)
local unemp. rate	0.043	0.024	0.041			-0.154	-0.145	-0.159		
	(0.155)	(0.159)	(0.149)			(0.114)	(0.116)	(0.114)		
community population	0.137**	0.129*	0.138**	0.134**	0.121*	-0.096	-0.102	-0.101	-0.101	-0.116
	(0.066)	(0.066)	(0.068)	(0.067)	(0.069)	(0.093)	(0.094)	(0.096)	(0.107)	(0.111)
log expenses	-0.013*	-0.013*	-0.013*	-0.012*	-0.012*	0.007	0.007	0.006	0.009	0.008
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)
log revenues	0.019***	0.019***	0.019***	0.021***	0.021***	0.001	0.001	0.003	0.004	0.006
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)
local property tax rate	-0.087**	-0.088**	-0.087**	-0.100***	-0.102***	0.063**	0.067***	0.065**	0.059**	0.066**
	(0.038)	(0.038)	(0.038)	(0.038)	(0.037)	(0.026)	(0.026)	(0.026)	(0.027)	(0.028)
firm-size year FE	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
Adjusted R^2	0.181	0.180	0.181	0.177	0.176	0.129	0.128	0.128	0.114	0.108
Observations	3204780	3204780	3204780	3204780	3204780	484767	484767	484767	484767	484767
Groups	1014992	1014992	1014992	1014992	1014992	202613	202613	202613	202613	202613
Clusters	395	395	395	395	395	350	350	350	350	350
Elasticity	-0.46	-0.49	-0.46	-0.50	-0.53					
Incidence	-0.67	-0.71	-0.67	-0.72	-0.77					

Note: All specifications include person, firm, municipal and year fixed effects as well as: skill-year, occupation-year, firm size-year, CBA type-year, state-year fixed effects. Standard errors (in parentheses) clustered at county level. Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).

The higher incidence implies an indirect wage effect of roughly 10 cents. This increase is too small to be statistically significant. Thus we cannot state that the

direct effect is different from the full effect. In line with the theoretical model and given the very local nature of the corporate tax, the small indirect effect may not be surprising. Workers are mobile within labor market regions, which prevents wages from falling when investment decreases. In fact, the companion paper by Siegloch (2013) shows that there is indeed a negative employment effect of the LBT, which can be attributed to local labor mobility.

Specifications (6) to (10) of Table 6 show further evidence of a negligible indirect effect by looking at firms without a collective bargaining agreement. Model (6) confirms that there is no direct effect for non-CBA firms. In specifications (7) to (10), we estimate the full, unconditional wage incidence model and find that there seems to be no indirect effect as the point estimate remains zero.

5.5 Heterogeneous worker effects

In this section we use the rich LIAB data to test whether different worker groups are affected differently by corporate taxation. Given the small indirect wage effect, we focus on the direct effect, excluding firms without a CBA and conditioning on employment, value added and investment in the estimation.

Skill. We start by testing one specific feature of our theoretical model, namely heterogeneous skill effects. As described in Section 4.2, we differentiate between three skill groups (high, medium and low). In order to test for heterogeneous worker effects, we interact the log collection rate with skill dummy variables. Specification (1) of Table 7 shows that the wage effect of corporate taxes is driven by medium-skilled workers. We neither find a significantly negative effect for high nor for low-skilled wages. Yet, it is possible that there are different adjustment speeds for different skill types. Hence, we also add interacted collection rates of period $t-1$ to the model (specification (2)). It turns out that corporate taxes also have a negative and significant long-run effect (the sum of the two coefficients for periods t and $t-1$) on high-skilled wages. In fact, the high-skilled long-run wage elasticity is more negative than the one for medium-skilled (-0.54 vs. -0.48). The effect on low-skilled workers remains small and not significantly distinguishable from zero. This suggests that the wage incidence is increasing in skill: the higher the qualification, the stronger the negative wage effect. This pattern is in line with intuition since it is more difficult to reduce the rents of low-skilled workers whose wage rates are already close to the implicit minimum wage, which is determined by unemployment benefits and social assistance. A tax increase in the bargaining model decreases the

overall rents to be shared between the firm and its workers. Worker groups that generally do not receive much of the rents do not have much to lose from the rent shock: bargaining power is self-defeating as shown in Section 3. In terms of the incidence, firms reduce the wage bill of the medium-skilled most, which is, of course, a pure size effect, given that 75% of the workers are medium-skilled.

Table 7: Effects on log wages: by skill

Model	(1)	(2)
log collection rate$_t$ x high skilled	-0.099	-0.081
	(0.073)	(0.058)
log collection rate$_t$ x medium skilled	-0.097**	-0.096**
	(0.045)	(0.046)
log collection rate$_t$ x low skilled	-0.061	-0.121
	(0.056)	(0.075)
log collection rate$_{t-1}$ x high skilled		-0.062
		(0.042)
log collection rate$_{t-1}$ x medium skilled		-0.027
		(0.033)
log collection rate$_{t-1}$ x low skilled		0.041
		(0.059)
Adjusted R^2	0.198	0.181
Observations	3512491	3204780
Groups	1085873	1014992
Clusters	395	395
Long run effect: high skilled	-0.099	-0.142*
Long run effect: medium skilled	-0.097**	-0.123**
Long run effect: low skilled	-0.061	-0.080
Wage elasticity: high skilled	-0.39	-0.54
Wage elasticity: medium skilled	-0.40	-0.48
Wage elasticity: low skilled	-0.26	-0.33
Euro incidence: high skilled	-0.12	-0.17
Euro incidence: medium skilled	-0.43	-0.56
Euro incidence: low skilled	-0.06	-0.08

Note: All specifications include the same control variables as the baseline (Table 4) including person, firm, municipal and year fixed effects as well as: skill-year, occupation-year, firm size-year, CBA type-year, state-year fixed effects. Standard errors (in parentheses) clustered at county level. Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).

Wage censoring. As stated above, we make a rather rigorous choice in treating censored wages. By dropping all workers that have once had a censored wage during the observation period, we exclude many high-skilled workers and supposedly keep a negatively selected group of the highly qualified. In the following we test the sensitivity of our results with respect to this choice. While specification (1) of Table 8 shows the baseline results, we relax the rigorous treatment of censored wages slowly when moving to the right: in model (2) we only drop the workers in years where wages are actually censored (as opposed to dropping all workers with once censored wages). In specification (3), we do not drop any observations but use the contribution ceiling as the wage when observations are censored. In the last model,

we impute censored wages using the Tobit-procedure provided by the IAB (Gartner, 2005).

Table 8: Effects on log wages: Sensitivity w.r.t wage censoring

Model	(1)	(2)	(3)	(4)
Wage treatment	person never censored	not censored in t	ceiling	imputed
log collection rate x high skilled	-0.099	-0.045	0.019	-0.017
	(0.073)	(0.074)	(0.049)	(0.057)
log collection rate x medium skilled	-0.097**	-0.105**	-0.107***	-0.124***
	(0.045)	(0.045)	(0.039)	(0.044)
log collection rate x low skilled	-0.061	-0.068	-0.072	-0.091
	(0.056)	(0.056)	(0.049)	(0.058)
Adjusted R^2	0.198	0.208	0.221	0.140
Observations	3512491	3820751	4592096	4592096
Groups	1085873	1197097	1373324	1373324
Clusters	395	395	395	395
Wage elasticity: high skilled	-0.39	-0.18	0.08	-0.07
Wage elasticity: medium skilled	-0.40	-0.43	-0.43	-0.51
Wage elasticity: low skilled	-0.26	-0.29	-0.31	-0.39
Euro incidence: high skilled	-0.12	-0.06	0.02	-0.02
Euro incidence: medium skilled	-0.43	-0.46	-0.46	-0.53
Euro incidence: low skilled	-0.06	-0.07	-0.07	-0.09

Note: All specifications include the same control variables as the baseline (Table 4) including person, firm, municipal and year fixed effects as well as: skill-year, occupation-year, firm size-year, CBA type-year, state-year fixed effects. Standard errors (in parentheses) clustered at county level. Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).

The results show that the treatment of censored wages affects skill groups differently. The coefficients for the medium- and low-skilled become slightly more negative, but expectedly do not change much as most of these workers earn wages below the contribution ceiling. In contrast, the coefficient on the high-skilled is very sensitive: it changes size and sign across specifications. Based on these insights, we argue that our rigorous sample selection with respect to the wage censoring is the only reliable way. This, however, might come at the cost that we are likely to face a negatively selected group of high-skilled workers. If this is the case, the true direct wage incidence for the high-skilled is probably even more negative, given that higher ability high-skilled are likely to extract more rents than lower ability high-skilled. Hence, our baseline estimates arguably provide a lower bound for high-skilled workers.

Worker characteristics. Next, we test for other heterogeneous worker effects (see Table 9) by interacting the log collection rate with various worker type dummy variables.[25] Specifications (1) and (2) show that there are neither significant differences by tenure nor by age groups. Moreover, we do not find different wage effects

[25] The base effects of the dummy variables are included but not shown in the table.

for blue and white-collar workers. Last in model (4), we differentiate between workers who switch firms and workers who stay in the same plant during our period of observation. The latter group is apparently less mobile and might therefore bear a higher corporate tax burden. In fact, as Table 9 suggests, job stayers show a much higher negative wage effect, whereas more mobile workers who change firms do not seem to be affected at all by the burden shifting of firms (the point estimate for job switchers is positive but not statistically significantly so).

Table 9: Heterogenous worker effects on log wages

Model	(1)	(2)	(3)	(4)
Group	firm tenure	age	collar type	mobility
log collection rate	-0.091*	-0.094**	-0.089*	-0.103**
	(0.047)	(0.046)	(0.046)	(0.046)
log collection rate ∗ medium	-0.004			
	(0.016)			
log collection rate ∗ high	0.007			
	(0.022)			
log collection rate ∗ medium		0.003		
		(0.010)		
log collection rate ∗ old		0.003		
		(0.019)		
log collection rate ∗ white collar			-0.027	
			(0.025)	
log collection rate ∗ mobile workers				0.214***
				(0.070)
Adjusted R^2	0.199	0.199	0.198	0.199
Observations	3512491	3512491	3512491	3512491
Groups	1085873	1085873	1085873	1085873
Clusters	395	395	395	395

Note: All specifications include the same control variables as the baseline (Table 4) including person, firm, municipal and year fixed effects as well as: skill-year, occupation-year, firm size-year, CBA type-year, state-year fixed effects. Standard errors (in parentheses) clustered at county level. Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).

5.6 Heterogeneous firm effects

Finally, we use the establishment part of the LIAB to check for heterogeneous firm effects. As done in Section 5.5, we focus on the direct wage effect for CBA firms. We start off by testing differences between corporate and non-corporate firms (*Personengesellschaften*). As noted above, the tax treatment of the two legal types is quite different. Non-corporate firms are not subject to the corporate tax but the personal income tax (on operating profits assigned to the proprietor), which is progressive and where marginal rates consequently depend on the taxable income. As for the LBT the definition of the base also differs compared to corporate firms.[26] As

[26] Non-corporate firms have an allowance of 24,500 euros. In addition, a share of the LBT liabilities can be deducted from the personal income tax base: $1.8 \cdot \tau_{fed} \cdot Y$ from 2001 to 2007

firm characteristics also differ strongly between corporate and non-corporate firms – notably in terms of size –, we split the sample and estimate the baseline model separately for both legal types. Despite the stark differences, specification (1) and (2) of Table 10 shows that point estimates and therefore wage elasticities are quite similar between corporate and non-corporate firms. Yet, the negative wage effect for non-corporate firms (specification (2)) is not statistically significant at conventional levels (p-value of 0.11). The wage incidence of non-corporate firms is only 30 cents as compared to 53 cents for corporate firms. This might be explained by lower bargaining power of workers in non-corporate firms where owners are more dominant and workers less organized.

Recall that our baseline sample is restricted to firms in the manufacturing sector. We estimate the baseline model also for the traffic and service sectors. Interestingly, we do not find significantly negative effects for the two other sectors as indicated by specifications (4) and (5) of Table 10, which could also be due to lower bargaining power of workers – especially in the service sector (where wages are closer to the implicit minimum wage).

Next, we run several interaction models to test for further firm heterogeneity. Table 11 shows the results. In model (1) we test whether there are differences between single and multi-establishment firms following the theoretical analysis of the tax incidence under formula apportionment shown in Appendix A. The interaction term is insignificant suggesting that the wage incidence does not differ between single and multi-establishment firms, which is not surprising given that the formula apportionment is based on the wage bill of the respective establishment.

Looking at the effects by firm size in specification (2), we find an interesting pattern: there are strong negative effects on wages for small firms with less than 50 employees and for larger firms with more than 250 workers. Medium-sized firms with a workforce of 50-250 do not seem to cut wages after increases of the LBT. Specifications (3) and (4) show that there are no differences in terms of the firm's profitability or between firms with and without a work council. Last, we use a survey question of the LIAB asking "whether local taxation was important for the initial location decision of the firm". Intuitively, we only find significantly negative

and $3.8 \cdot \tau_{fed} \cdot Y$ since 2008 onwards. Moreover, there was a reduced τ_{fed} for small non-corporate firms prior to 2008: for every 12,000 euros exceeding the allowance of 24,500 euros, τ_{fed} was raised by one percentage point so that the full basic federal rate of 5.0% had to be paid with a taxable income starting from 72,500 euros. Assuming that profits of the firms are so high that companies are in the highest PIT bracket and face the top marginal tax rate, τ_{PIT}^{top}, the effective marginal tax rate for a non-corporate firms $\tau_{EMTR}^{non-corp}$ from 1998 to 2007, is $\tau_{EMTR}^{non-corp} = \frac{\tau_{PIT}^{top} \cdot (1+soli)+\tau_{fed} \cdot cr}{1+\tau_{fed} \cdot 1.8}$. Since 2008 the denominator of the fraction is set to $1 + \tau_{fed} \cdot 3.8$.

Table 10: Effects on log wages - by legal form and industry

Model	(1)	(2)	(3)	(4)	(5)
Sample	Legal type		Industry		
	corporate	non-corporate	manufacturing	traffic	services
log collection rate	-0.093**	-0.102	-0.093**	-0.061	-0.023
	(0.045)	(0.064)	(0.045)	(0.045)	(0.066)
log value added	0.004**	0.007***	0.004**	-0.002	0.001
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
log investment	-0.000	-0.003*	-0.000	0.006*	0.001
	(0.001)	(0.002)	(0.001)	(0.003)	(0.001)
log employees	0.032***	0.049***	0.032***	-0.040***	0.021***
	(0.009)	(0.010)	(0.009)	(0.015)	(0.007)
log full-time hours	0.033	0.064	0.033	0.098	0.021
	(0.040)	(0.051)	(0.040)	(0.063)	(0.034)
work council	0.006**	0.009	0.006**	0.020*	0.004
	(0.003)	(0.010)	(0.003)	(0.011)	(0.006)
share high-skilled employees	0.002	-0.076	0.002	0.013	0.154***
	(0.058)	(0.090)	(0.058)	(0.146)	(0.042)
share medium-skilled employees	-0.020	-0.056	-0.020	0.137*	-0.011
	(0.048)	(0.035)	(0.048)	(0.070)	(0.023)
local unemp. rate	-0.026	0.004	-0.026	-0.418	-0.095
	(0.145)	(0.257)	(0.145)	(0.360)	(0.173)
community population	0.106*	-0.026	0.106*	0.041	0.184***
	(0.062)	(0.092)	(0.062)	(0.104)	(0.069)
log expenses	-0.013**	0.001	-0.013**	0.004	0.021***
	(0.007)	(0.008)	(0.007)	(0.022)	(0.007)
log revenues	0.017**	0.009	0.017**	-0.012	-0.008
	(0.007)	(0.008)	(0.007)	(0.029)	(0.009)
local property tax rate	-0.079**	0.008	-0.079**	0.068	-0.025
	(0.037)	(0.038)	(0.037)	(0.057)	(0.029)
Adjusted R^2	0.198	0.203	0.198	0.145	0.113
Observations	3512491	201603	3512491	339154	467551
Groups	1085873	92557	1085873	98385	212523
Clusters	395	316	395	167	323
Elasticity	-0.38	-0.39	-0.38	-0.25	-0.09
Incidence	-0.53	-0.30	-0.53	-0.44	-0.02

Note: All specifications include person, firm, municipal and year fixed effects as well as: skill-year, occupation-year, firm size-year, CBA type-year, state-year fixed effects. Standard errors (in parentheses) clustered at county level. Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).

tax effects for firms that cared about local taxation when choosing their location and thus already demonstrated their tax sensitivity.

Table 11: Heterogenous firm effects on log wages

Model	(1)	(2)	(3)	(4)	(5)
Group	establishment type	firm size	profitability	work council	tax salience
log collection rate	-0.115**	-0.139**	-0.097**	-0.080*	-0.071
	(0.056)	(0.066)	(0.047)	(0.048)	(0.072)
log collection rate * stand alone	0.025				
	(0.030)				
log collection rate * 50-250 employees		0.117**			
		(0.051)			
log collection rate * 250-1000 employees		0.035			
		(0.062)			
log collection rate * >1000 employees		0.027			
		(0.078)			
log collection rate * poor			0.014		
			(0.015)		
log collection rate * work council				-0.013	
				(0.022)	
log collection rate * local tax relevant.					-0.047
					(0.089)
Adjusted R^2	0.199	0.199	0.199	0.198	0.213
Observations	3495591	3512491	3512491	3512491	2551316
Groups	1080893	1085873	1085873	1085873	647658
Clusters	394	395	395	395	364

Note: All specifications include the same control variables as the baseline (Table 4) including person, firm, municipal and year fixed effects as well as: skill-year, occupation-year, firm size-year, CBA type-year, state-yea r fixed effects. Standard errors (in parentheses) clustered at county level. Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).

6 Conclusions

How much of the corporate tax burden is borne by workers? While this question has been heavily discussed ever since Harberger (1962)'s seminal work, compelling empirical evidence is scarce due to tough requirements that have to be met in order to identify the full wage effect. In this paper, we use the institutional setting of German corporate taxation that provides a nearly ideal laboratory to answer this question. On average 8% of the 11,441 German municipalities change their corporate tax rates per year. We link administrative information on the universe of the German municipalities from 1998 to 2008 to high-quality administrative linked employer-employee data to estimate the effect of corporate taxation on individual wages. Moreover, local corporate tax autonomy allows us to treat the German municipalities as many small open economies and thereby gauge the full incidence of corporate taxation on wages, including often neglected indirect effects related to the adjustment of investment and other input factors.

We find that a 1% increase in the corporate tax rate leads to a $0.3 - 0.5\%$ decrease in wages. This implies that for every additional tax euro a firm has to pay, the wage bill declines by $44 - 77$ cents. We decompose the full incidence into a direct effect arising from wage bargaining and an indirect effect driven by the adjustment

of other inputs. In line with our theoretical model, we find that the direct effect that arises in a collective bargaining context is indeed only found for firms where wages are set by union-firm bargaining. We also find that the negative direct wage incidence is increasing in skills. In contrast to the direct effect, we find rather small estimates for the indirect effect. This could be due to the specific institutional setting of the local business tax as discussed below.

Our theoretical and empirical findings have important policy implications. In the public and political debate arguments in favor of (higher) corporate taxes are often based on redistributive motives: allegedly rich firm owners shall contribute to financing public goods and social safety nets by paying their fair share of taxes.[27] Opponents of high corporate taxes often claim that eventually the tax burden is (fully) shifted to labor, being immobile in an international context.

The findings presented in this paper shed new light on this debate and show that the shifting of the corporate tax burden is more complex. Due to the separation between a direct and an indirect effect, we are able to demonstrate two general mechanisms, which are pivotal for the corporate tax incidence on wages. First, if there are rents to be shared, groups with larger rents will bear a higher corporate tax burden. Second, the indirect effect is determined by the mobility of the production factors in relation to the jurisdictional level at which the tax is set.

With regard to the rent sharing, it is important to distinguish between two levels at which rents can be shared. On the one hand, rents are shared between capital and labor. In this respect, we generally find that labor bears a substantial share of the corporate tax burden when collective bargaining agreements are in place.[28] In turn, this result suggests that if rents were predominantly extracted by capitalists and firm owners – for instance in a nationwide competitive labor market, corporate taxation would be less harmful for workers. On the other hand, the tax burden falling on labor is shared within the workforce. We find that high skilled

[27] See, for example, the recent debate in the United Kingdom about big multinational firms like the online retailer Amazon or the coffee chain Starbucks that have paid small amounts of corporate taxes despite large revenues in the past. While this specific debate rather focuses on loopholes in the tax base through tax avoidance possibilities of multinationals, it shows that many people expect firms to pay more taxes to contribute to the public good (see http://www.bbc.co.uk/news/business-19967397).

[28] At first sight, this may seem to be contradictory to the tax avoiding activities of many multinational firms, which shift profits to affiliates in low tax jurisdictions. Yet, there might be an interdependence between profit shifting to affiliates and burden shifting to workers, as suggested by Krautheim and Schmidt-Eisenlohr (2012): firms with corporate bargaining agreements in high tax-jurisdictions should, in fact, have the incentive to shift profits abroad to reduce the observable surplus lowering rents and their seeming bargaining power.

workers bear a larger part of the corporate tax burden. Again, if we assume that bargaining power is increasing in skill, this result is consistent with the theoretical prediction that those who extract the highest rents will bear the largest share of the tax burden. From a redistributive perspective, this might be seen as a desirable feature.

Looking at the indirect wage effect, the following implications can be drawn from our analysis – independently from the direct wage effect. The negligible indirect effects suggest that *local* corporate taxation might offer a possibility to prevent firm owners from shifting large(r) shares of the tax burden to workers. If labor is regionally mobile, *competitive* wages are determined within the regional or even the national labor market and should hardly respond to the tax changes in a small jurisdiction – in line with the zero result for firms without CBAs.[29] Hence, this argument is very similar to the one presented in studies on the incidence of nationwide corporate taxes on mobile capital in an international setting.

The latter argument immediately raises the question on the generalizability of our findings investigating local corporate taxes in a very specific institutional setting. First, there is no reason to expect the direct wage effect to be different when looking at national corporate taxes, as the rationale of self-defeating bargaining power in a rent sharing setting is very general (Arulampalam et al., 2012). Second, the finding of negligible general equilibrium wage effects – which is in contrast to previous findings – demonstrates the central role of the underlying mobility of production factors. On the one hand, it is likely that the indirect wage effect is higher when analyzing the incidence of a nationwide corporate tax on wages given lower cross-country labor mobility. On the other hand, there are presumably large differences between small open economies exhibiting some labor mobility and large economies like the U.S. where mobility to move abroad should be quite low. This suggests that the indirect wage effect always depends on the specific jurisdictions and tax setting regimes under study. The identification of a universal estimate of the average general equilibrium wage effect in an international setting is likely to be an unachievable challenge – at least when using real world data. In order to answer this general question, CGE models seem to be the only option. It would be worthwhile to replicate our empirical findings in such a model with local corporate tax autonomy and in a second step to extrapolate the effects to the national level.

[29] Labor as whole can still lose despite the negligible indirect effect on local wages as repelled labor leads to many small but in sum substantial decreases in the marginal products (and thus in wages) in the labor absorbing low-tax municipalities (Bradford, 1978).

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A Appendix A (For Online Publication)

In this appendix we briefly discuss some additional aspects of the corporate tax incidence on wages implied by the wage bargaining model developed in Section 3.

Indirect effect First, consider the impact of changes in the corporate tax rate on demand for inputs. Standard comparative analysis of equations (2) and (4) shows that the impact of corporate tax changes on demand for labor of skill type $k \neq j$ is

$$\frac{\partial L_i^k(R_i, \overline{w}_i^1, \overline{w}_i^2)}{\partial R_i} = \frac{1}{\Delta}\left(\frac{\partial^2 F(K_i, L_i^1, L_i^2)}{\partial L_i^k \partial L_i^j}\frac{\partial^2 F(K_i, L_i^1, L_i^2)}{\partial L_i^j \partial K_i} - \frac{\partial^2 F(K_i, L_i^1, L_i^2)}{\partial L_i^j \partial L_i^j}\frac{\partial^2 F(K_i, L_i^1, L_i^2)}{\partial L_i^k \partial K_i}\right)$$

where $\Delta < 0$ is the determinant of the Hessian matrix of the production function. The concavity of the production function implies $\Delta < 0$. As stated in the text, the equation shows that a sufficient condition for $\frac{\partial L_i^k(R_i, \overline{w}_i^1, \overline{w}_i^2)}{\partial R_i} < 0$ is that both skill types are complements for each other and for capital in the production function $\frac{\partial^2 F(K_i, L_i^1, L_i^2)}{\partial L_i^k \partial L_i^j}$, $\frac{\partial^2 F(K_i, L_i^1, L_i^2)}{\partial L_i^j \partial K_i}$, $\frac{\partial^2 F(K_i, L_i^1, L_i^2)}{\partial L_i^k \partial K_i} > 0$. But in general the sign of $\frac{\partial L_i^k(R_i, \overline{w}_i^1, \overline{w}_i^2)}{\partial R_i}$ may be positive or negative.

Sector level bargaining Next we provide the proof of result 3, which states that the magnitude of the effect of a tax change in jurisdiction i on the wage is larger under firm level bargaining than under sector level bargaining. Differentiating the wage equation (9) with respect to τ_i and using equation (10) yields

$$\frac{dw^{ks*}}{d\tau_i} \mid_{dL_h^k = dL_h^j = dK_h = 0} = \frac{L_h^k}{\sum_{i=1}^{m}[L_i^k(1-\tau_i)]} \left(w^{ks*} + \frac{\Psi}{(1-\beta^k\beta^j)}\right),$$

where

$$\Psi = -\overline{w}^k(1-\beta^k)L_h^k + \overline{w}^j(1-\beta^j)\beta^k L_h^j - (1-\beta^j)\beta^k[F_i(K_h, L_h^1, L_h^2) - \alpha r K_h].$$

In the case of firm level bargaining ($m = 1$), the direct effect can be expressed as

$$\frac{dw^{k*}}{d\tau_i} \mid_{dL_h^k = dL_h^j = dK_h = 0} = \frac{1}{(1-\tau_h)} \left(w^{ks*} + \frac{\Psi}{(1-\beta^k\beta^j)}\right),$$

which is unambiguously larger since

$$\frac{L_h^k}{\sum_{i=1}^{m}[L_i^k(1-\tau_i)]} < \frac{1}{(1-\tau_h)}.$$

Formula apportionment Finally, we discuss the implications of formula apportionment for our theoretical analysis. If firms have plants in more than one municipality, the LBT in Germany uses formula apportionment to allocate the taxing rights to the different municipalities. The formula used in Germany is based on payroll as the only apportionment factor.[30] Given this, the impact of tax changes on wages may be different. Consider a company with plants in two jurisdictions i and j. After tax profits of the company are

$$P^{FA} = [F(K_i, K_j, L_i^1, L_i^2, L_j^1, L_j^2) - \sum_{k=1}^{2} w^k L_i^k - \sum_{k=1}^{2} w^k L_j^k](1-\tau_{ij}) - (1-\alpha\tau_{ij})r[K_i + K_j]$$

with obvious notation. We assume that wage bargaining takes place at the firm level, not at the plant level, and that wages paid to workers of a given skill group are the same in the two plants. The profit tax rate is now given by

$$\tau_{ij} = T + (1-T)\frac{\theta_i \sum_{k=1}^{2} w^k L_i^k + \theta_j \sum_{k=1}^{2} w^k L_j^k}{\sum_{k=1}^{2} w^k L_i^k + \sum_{k=1}^{2} w^k L_j^k}$$

The main difference to the case where firms just operate in one jurisdiction is that the profit tax rate itself now depends on wages and the distribution of employment at the two plants, i.e. $\tau_{ij} = \tau_{ij}(w^1, w^2, L_1^1 ...)$, with

$$\frac{\partial \tau_{ij}}{\partial w^l} = [\theta_i - \theta_j]\left[\frac{L_i^l}{L_i^m} - \frac{L_j^l}{L_j^m}\right] L_i^m L_j^m \frac{(1-T)}{\gamma} \quad l = 1, 2,\ l \neq m,$$

where

$$\gamma = \left[1 + \frac{w^l L_i^l + w^m L_i^m}{w^l L_j^l + w^m L_j^m}\right]^2 [w^l L_j^l + w^m L_j^m]^2 > 0.$$

Assume, for instance, that municipality i has a higher tax rate than municipality j, and assume that the wage of the low-skilled increases. In this case the impact on the tax burden will depend on whether this increases the payroll share of the high or that of the low tax municipality. If the share of low-skilled is higher in jurisdiction i so that $\left[\frac{L_i^l}{L_i^m} - \frac{L_j^l}{L_j^m}\right] > 0$, the tax rate τ_{ij} will increase, and vice versa. Therefore the effect of a wage change on the tax rate is ambiguous for the general case.

The fact that the firm's profit tax rate is now a function of the wage rates also implies that the direct effect of a change in the local corporate tax rate t on wages as defined in the preceding sections is now ambiguous. The Nash maximand of the

[30] In cases where this leads to an outcome which is obviously inappropriate, the tax rate can be divided differently. But in most cases the payroll based formula is applied.

union-form bargaining problem is now given by

$$\Omega_i^{kFA} = \beta^k \ln Z_i^k + (1-\beta^k) \ln P^{FA}$$

The equilibrium wage rates are

$$w^{kFA*} = \overline{w}^k + \frac{\beta^k}{(1-\beta^k)} \frac{P^{FA}}{[(L_i^k + L_j^k)(1-\tau_{ij}) - \Phi]} \quad k = 1, 2, \tag{12}$$

where

$$\Phi = \frac{\partial P^{FA}}{\partial \tau_{ij}} \frac{\partial \tau_{ij}}{\partial w^k}.$$

Equation (12) implicitly defines the two wage rates emerging from the bargaining process as reaction functions of the type $w^{lFA*} = w^{lFA*}(w^{mFA*}, \theta_i, \theta_j, T...)$. Differentiating equation (12) shows that the direct effect of a change in the local corporate tax rates on the equilibrium wage rates is, in general, ambiguous.[31] This suggests that the incidence of the local corporate tax on wages in firms with plants in multiple jurisdictions could differ systematically from the incidence in firms which operate in one jurisdiction only, but the sign of the effects is ambiguous. In the empirical analysis, the role of formula apportionment is investigated by distinguishing between single and multi-establishment firms.

[31] Unambiguous results only emerge if there is only one skill group. In this case, it is straightforward to show that the effects of a profit tax change in one jurisdiction on wages in that jurisdiction is smaller than it would be in a single plant firm.

B Appendix B (For Online Publication)

Table B.1: Robustness: effects on wages in levels

Model	(1)	(2)	(3)	(4)
log collection rate$_t$	-0.093**	-0.098**		
	(0.045)	(0.048)		
log collection rate$_{t-1}$		-0.019		
		(0.034)		
collection rate			-0.028**	-0.031**
			(0.013)	(0.014)
collection rate$_{t-1}$				-0.004
				(0.010)
log value added	0.004**	0.004**	0.004**	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)
log investment	-0.000	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
log employees	0.032***	0.033***	0.032***	0.033***
	(0.009)	(0.010)	(0.009)	(0.010)
log full-time hours	0.033	0.035	0.033	0.035
	(0.040)	(0.040)	(0.040)	(0.040)
work council	0.006**	0.007*	0.006**	0.007*
	(0.003)	(0.004)	(0.003)	(0.004)
share high-skilled employees	0.002	0.001	0.001	0.000
	(0.058)	(0.061)	(0.058)	(0.060)
share medium-skilled employees	-0.020	-0.023	-0.019	-0.023
	(0.048)	(0.052)	(0.048)	(0.051)
local unemp. rate	-0.026	0.043	-0.028	0.042
	(0.145)	(0.155)	(0.145)	(0.154)
community population	0.106*	0.137**	0.104*	0.134**
	(0.062)	(0.066)	(0.062)	(0.066)
log expenses	-0.013**	-0.013*	-0.013**	-0.013*
	(0.007)	(0.007)	(0.007)	(0.007)
log revenues	0.017**	0.019***	0.017**	0.019***
	(0.007)	(0.007)	(0.007)	(0.007)
local property tax rate	-0.079**	-0.087**	-0.076**	-0.083**
	(0.037)	(0.038)	(0.036)	(0.037)
Adjusted R^2	0.198	0.181	0.198	0.181
Observations	3512491	3204780	3512491	3204780
Groups	1085873	1014992	1085873	1014992
Clusters	395	395	395	395
Elasticity	-0.38	-0.46	-0.46	-0.54
Incidence	-0.53	-0.67	-0.64	-0.79

Note: All specifications include person, firm, municipal and yea r fixed effects as well as: skill-year, occupation-year, firm size-year, CBA type-year, state-year fixed effects. Standard errors (in parentheses) clustered at county level. Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).

Table B.2: Robustness: Effects on log wages - different fixed effects

Model	(1)	(2)	(3)	(4)
Fixed Effects	Baseline	Only Worker	Only Firm	Only Municipal
log collection rate	-0.098**	-0.098**	-0.059	-0.009
	(0.046)	(0.046)	(0.049)	(0.068)
log value added	0.004**	0.004**	0.005***	0.012***
	(0.002)	(0.002)	(0.002)	(0.003)
log investment	-0.000	-0.000	-0.001	0.004**
	(0.001)	(0.001)	(0.001)	(0.002)
log employees	0.031***	0.031***	0.020**	-0.002
	(0.009)	(0.009)	(0.009)	(0.007)
log full-time hours	0.036	0.036	0.015	-0.264***
	(0.041)	(0.041)	(0.046)	(0.072)
work council	0.006**	0.006**	0.002	0.096***
	(0.003)	(0.003)	(0.004)	(0.013)
share high-skilled employees	-0.000	-0.000	0.030	0.099**
	(0.058)	(0.058)	(0.054)	(0.047)
share medium-skilled employees	-0.022	-0.022	-0.032	0.087**
	(0.049)	(0.049)	(0.041)	(0.039)
local unemp. rate	-0.023	-0.023	-0.059	-0.301
	(0.148)	(0.148)	(0.140)	(0.184)
community population	0.103*	0.103*	0.100	0.006
	(0.062)	(0.062)	(0.064)	(0.090)
log expenses	-0.011	-0.011	-0.010	-0.002
	(0.007)	(0.007)	(0.007)	(0.007)
log revenues	0.016**	0.016**	0.019***	0.017*
	(0.007)	(0.007)	(0.007)	(0.008)
local property tax rate	-0.081**	-0.081**	-0.049	-0.070
	(0.038)	(0.038)	(0.042)	(0.047)
Adjusted R^2	0.200	0.200	0.214	0.238
Observations	3305718	3305718	3305718	3305718
Groups	984019	984019	2919	1412
Clusters	395	395	395	395
Elasticity	-0.40	-0.40	-0.24	-0.04
Incidence	-0.56	-0.56	-0.33	-0.05

Note: Dependent variable: log monthly wage. All specifications include year fixed effects as well as year-industry fixed effects. Clustered standard errors in parentheses. Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).