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Abstract

This paper estimates the incidence of corporate taxes on wages using a 20-year panel of German municipalities exploiting 6,800 tax changes for identification. Using event study designs and differences-in-differences models, we find that workers bear about half of the total tax burden. Administrative linked employer-employee data allow us to estimate heterogeneous firm and worker effects. Our findings highlight the importance of labor market institutions and profit-shifting opportunities for the incidence of corporate taxes on wages. Moreover, we show that low-skilled, young and female employees bear a larger share of the tax burden. This has important distributive implications.

JEL-Code: H200, H700, J300.

Keywords: business taxation, incidence, administrative data, local taxation.

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1 Introduction

The incidence of corporate taxation is a key issue in tax policy debates. The distribution of the tax burden between labor and capital has important implications for the progressivity of the tax system. According to surveys, most people think that capital owners bear the burden of corporate taxation.[1] Business lobbyists, in contrast, argue that the tax reduces investment so that labor productivity and wages decline, which means that workers bear the tax burden. Most economists take a middle ground and think that the tax burden is shared between labor and capital. Yet, even among researchers in the field, there is substantial disagreement about how much of the burden is shifted to workers.[2] The main reason is that credible empirical evidence on the causal effect of corporate taxes on wages is scarce. In this paper, we revisit the question of how corporate taxes affect wages.

We exploit the specific institutional setting of the German local business tax (LBT) to identify the corporate tax incidence on wages. The German setting is well-suited for several reasons. First, there is substantial tax variation at the local level. From 1993 to 2012, on average about 10% of all municipalities adjusted their LBT rates annually, resulting in 17,999 tax changes in 10,001 municipalities between 1993 and 2012. Second, municipalities can only change the LBT *rate*. The tax base definition and rules about which types of firms are liable to the tax are determined at the federal level.[3] Moreover, municipal autonomy in setting tax rates allows us to treat municipalities as many small open economies within the highly integrated German national economy – with high mobility of capital, labor and goods across municipal borders. In this setting, general equilibrium effects on interest rates or consumer prices, which may complicate measuring the incidence of the tax on workers, are likely to be of minor importance.

Our analysis combines administrative panel data on the universe of German municipalities with administrative linked employer-employee micro data from social security records. In this data, we observe firms in 3,522 municipalities, leaving us with 6,802 tax changes for identification. We use non-parametric event study designs to show that wages decrease significantly after tax increases. At the same time, they do not react in the periods prior to a tax reform. In addition, we use the event study set-up to show that tax reforms are not driven by local business cycles. These flat pre-trends support our identifying assumption and the causal interpretation of our estimates.

[1] See, e.g., Sheffrin (1994) and various Gallup polls: http://www.gallup.com/poll/1714/taxes.aspx.

[2] For example, public economists surveyed by Fuchs, Krueger and Poterba (1998) respond on average that 40% of the corporate tax incidence is on capital, leaving a substantial share of the burden for labor (and land owners or consumers). However, one quarter of the surveyed economists believed that the capital share is below 20%, while another quarter believed the share to be 65% or higher.

[3] Kawano and Slemrod (2016) compare a large number of reforms of nationwide corporate taxes and show that tax rate changes are usually combined with changes in the tax base as well.

We then estimate differences-in-differences (DiD) models to quantify the magnitude of the wage response. Averaging over all firms liable to the LBT, we find that workers bear approximately 51% of the total tax burden.[4] Our findings are robust to the inclusion of a comprehensive set of flexible non-parametric local controls at different aggregation levels, suggesting that potentially relevant omitted variables such as local shocks are not driving the results. Finally, we estimate various heterogeneous firm and worker effects and discuss the results with regard to different (labor market) theories.

We contribute to the literature in several ways. We provide new estimates of the corporate tax incidence on wages by exploiting the compelling German institutional setting. So far, credible empirical evidence on the incidence of corporate taxes has been scarce because sufficient and exogenous variation in corporate tax rates is lacking in previous studies. While cross-country research designs (such as Hassett and Mathur, 2006; Felix, 2007; Desai, Foley and Hines, 2007; Clausing, 2013; Azémar and Hubbard, 2015) need to defend their (implicit or explicit) common trend assumptions, single-country designs can establish a valid control group more easily. Most existing single-country studies (see, e.g., Dwenger, Rattenhuber and Steiner, 2011; Arulampalam, Devereux and Maffini, 2012; Liu and Altshuler, 2013), however, have to rely on variation in the tax burden that is not solely driven by policy reforms but also by firms' choices. For instance, differences in tax burdens across industries or across regions due to formula apportionment may depend directly on sales and investment activities, which may be endogenous to tax rates. The contribution of our paper is to exploit substantial within-country variation in statutory municipal tax rates. In a recent contribution, Suárez Serrato and Zidar (2016) estimate the incidence of U.S. state-level corporate taxes using a spatial equilibrium framework exploiting regional variation in tax rates and apportionment rules.[5] The German setting has the advantage to offer substantially larger variation in terms of both number and size of tax rate changes.

Furthermore, we go beyond a cleanly identified average effect of corporate taxes on wages and analyze the economic factors driving these changes. We estimate heterogeneous firm effects and discuss the results in light of different labor market theories and tax incidence mechanisms. The German labor market, with its variety of wage-setting institutions, is particularly useful for this exercise. Exploiting the rich administrative linked employer-employee data, we find that labor market institutions matter for the incidence

[4] We observe only very few nominal wage decreases in the data but rather smaller wage increases leading to lower future wage levels in the treated municipalities.

[5] Felix and Hines (2009) also use U.S. state tax variation but rely on cross-sectional data. Bauer, Kasten and Siemers (2012) also investigate the German LBT but without using linked employer-employee data. Moreover, as in an earlier version of this paper (Fuest, Peichl and Siegloch, 2011), they have to average tax rates at the county level (consisting of 28 municipalities on average) which leads to biased results.

of corporate taxes on wages. In particular and in line with Felix and Hines (2009) and Arulampalam, Devereux and Maffini (2012), collective bargaining agreements play a key role: If wages are set via collective bargaining at the firm level, wage responses are larger than in cases where wages are set at the sector level or without collective bargaining. Overall, our results suggest that the higher the rents to be shared between firms and workers, the higher the pass-through on wages. For instance, wages are more sensitive to tax changes in more profitable firms. However, we find that wage effects are close to zero for very large firms, foreign-owned firms and for firms that operate in multiple jurisdictions. This can be explained by better profit-shifting capabilities of these firms. In general, the interaction of labor market institutions, avoidance opportunities and tax rates has received little attention in the literature on the incidence of corporate taxes, both theoretically and empirically. Our heterogeneous firm effects show that such interactions affect wage responses. This has implications beyond the German setting. While labor market institutions differ internationally, most countries exhibit a mixture of unionized and non-unionized firms or sectors, so that the heterogeneous effects we find in our setting are likely to be relevant in many other countries as well. This is also true for the differences between firm types, in particular the finding that higher taxes do not seem to reduce wages in firms with profit-shifting opportunities.

Last, we add to the distributional debate about the burden of corporate taxation. By estimating the tax incidence for heterogeneous worker groups we show that higher taxes reduce wages most for the low-skilled, women, and young workers. Both the average pass-through on wages of 51% and the heterogeneous worker effects are important for tax policy because they qualify the widespread view that the corporate income tax is highly progressive. In a back-of-the-envelope calculation based on Piketty and Saez (2007), we show that the estimated progressivity of the overall tax systems in both Germany and the U.S. would decrease by 25-40% if we account for our incidence estimates.

Our analysis focuses on the corporate tax incidence on workers and therefore on the causal *wage* response to corporate tax changes. We do not investigate the impact on input factors, production levels, firm entry or exit. Studying these other margins is important to understand the overall efficiency costs of corporate taxes. Such an analysis would, however, be complicated by data (linkage) limitations and is beyond the scope of this paper.

The rest of this paper is structured as follows. In Section 2, we describe the institutional setting of business taxation in Germany and introduce the datasets used in the empirical analysis. The empirical model is presented in Section 3. In Section 4, we present our main estimates of the corporate tax incidence on wages. Section 5 provides evidence on heterogeneous worker and firm effects which we discuss with respect to different theoretical models and mechanisms. Section 6 concludes.

2 Institutional background and data

We estimate the incidence of corporate taxes on wages by exploiting the particular features of the German business tax system. We describe this system in Subsection 2.1, with a special emphasis on the local business tax (LBT, *Gewerbesteuer*). In Subsection 2.2, we document the cross-sectional and time variation of the LBT. In Subsection 2.3, we introduce the administrative linked employer-employee data set, while Subsection 2.4 contains the definition of our estimation sample and descriptive statistics.

2.1 Business taxation in Germany

There are three taxes on business profits in Germany: the municipal LBT as well as the corporate income tax (CIT, *Körperschaftsteuer*) and the personal income tax (PIT, *Einkommensteuer*) which are both set by the federal government. In the following, we describe the LBT, while the CIT and PIT are described in Appendix B.1.

The LBT applies to both corporate and non-corporate firms, but most firms in the agricultural and public sector are not liable.[6] The tax base of the LBT is basically operating profits. The cost of debt financing is deductible, with some limitations[7], and the cost of equity financing is not. Taxable profits of firms with establishments in more than one municipality are divided between municipalities according to formula apportionment based on the payroll share. Importantly, the local government can change the tax rate but neither the tax base nor the liability criteria. Both are set at the federal level.

The tax rate, τ_{LBT}, consists of two components: the basic rate (*Steuermesszahl*), t_{LBT}^{fed}, which is set at the federal level, and a local scaling factor (*Hebesatz*), θ_{LBT}^{mun}, which is set at the municipal level. Each year, the municipal council votes on next year's θ_{LBT}^{mun} – even if it remains unchanged. The total LBT rate is given by $\tau_{LBT} = t_{LBT}^{fed} \cdot \theta_{LBT}^{mun}$. From 1993 to 2007, t_{LBT}^{fed} was 5.0% and decreased to 3.5% in 2008. For example, for the median θ_{LBT}^{mun} of 3.9, τ_{LBT} was 19.5% before 2008. In the empirical analysis, we rely on variation in τ_{LBT} induced by changes in θ_{LBT}^{mun} (described next).

[6] To be precise, paragraphs 2 and 3 of the LBT law (*Gewerbesteuergesetz*) regulate which firms are exempt from the LBT. The main criteria are interactions of legal form and industry. Moreover, certain professions such as accountants, lawyers, journalists or physicians are exempt.

[7] A special feature of the LBT is that 25% of interest costs are added to the tax base. Another peculiarity is that until 2007, the LBT itself was deductible as an expense.

2.2 Municipal data and tax rate variation

We use administrative statistics provided by the Statistical Offices of the 16 German federal states (*Statistische Landesaemter*) on the fiscal situation of all 11,441 municipalities. Most importantly, the dataset contains information on θ_{LBT}^{mun}, but also on population, municipal spending and revenues. In addition, we observe county (*Kreis*) level GDP as well as unemployment rates compiled by the German federal employment agency.

We combined and harmonized the annual state-specific datasets and constructed a panel on the universe of all municipalities from 1993 to 2012. In the administrative wage data (see Section 2.3), we can identify municipalities according to their boundaries as of 2010. Due to mergers, various municipal borders predominantly in East Germany changed prior to 2010. As we cannot assign the exact LBT rate for affected jurisdictions, we exclude all municipalities that underwent a municipal merger between 1993 and 2010 from our baseline sample. This concerns 47% of East German and 0.6% of West German municipalities.[8] Overall, there are 10,001 non-merged municipalities in Germany.

Figure 1 visualizes the substantial cross-sectional and time variation in LBT rates. The left panel of the figure shows the cross-sectional variation in τ_{LBT} for the year 2003, the mid-year of our sample.[9] Appendix Table C.1 provides measures of the distribution of θ_{LBT}^{mun} over time. The right panel of Figure 1 illustrates this time variation by showing the number of changes in θ_{LBT}^{mun} per municipality during the period 1993–2012 (Appendix Table C.2 shows the corresponding numbers). Overall, 19% of the non-merged municipalities did not change θ_{LBT}^{mun} during the 20-year period. More than half of the jurisdictions changed it once or twice, and only 7.5% experienced 4 or more changes. In total, we observe 17,999 tax rate changes in 10,001 non-merged municipalities.

[8] East German municipalities were rather small after reunification in 1990 and were subsequently merged (sometimes several times) to bigger jurisdictions. As a sensitivity check, we impute tax rates for merged municipalities by using weighted averages. See Appendix C for a more detailed discussion of the jurisdictional changes and Figure C.1 showing the tax rate variation including merged municipalities.

[9] The cross-sectional variation reveals some regional clustering: for instance, scaling factors are higher in the state of North Rhine Westphalia. This is partly due to particularities of that state's fiscal equalization scheme. Empirically, we account for such differences by including "state × year' fixed effects.

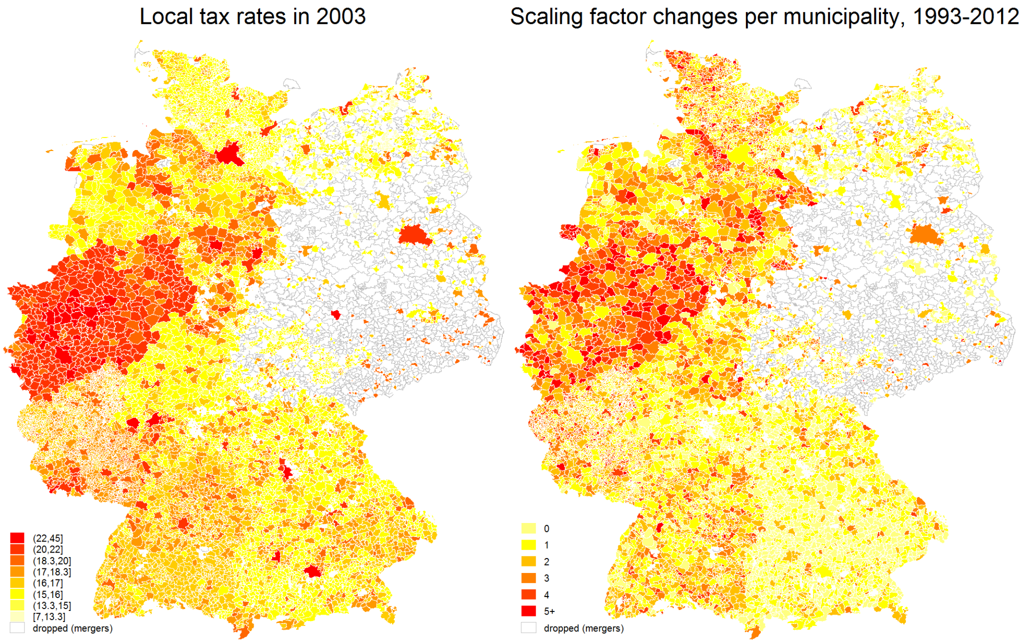


Figure 1: Cross-sectional and time variation in local tax rates

Source: Statistical Offices of the Laender. Maps: GeoBasis-DE / BKG 2015. *Notes:* This figure shows the cross-sectional and time variation in municipal scaling factors of the German LBT. The left graph plots the cross-sectional variation in LBT rates (in %) induced by different scaling factors for 2003 (the mid-year of our sample). The right graph indicates the number of scaling factor changes per municipality between 1993 and 2012. White areas are municipalities that underwent a change of boundaries due to a merger; which are dropped from the baseline sample (see Appendix Figure C.1 for the same graphs including the dropped municipalities). Jurisdictional boundaries are as of December 31, 2010.

2.3 Linked employer-employee data

We combine the municipal data presented in the previous subsection with linked employer-employee data (LIAB) provided by the Institute of Employment Research (IAB). The LIAB combines administrative worker data with firm-level data (Alda, Bender and Gartner, 2005).

The firm component of the LIAB is the IAB Establishment Panel (Kölling, 2000), which is a 1% 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. The employer data covers establishments with at least one worker subject to social insurance contributions and contains about 15,000 establishments. We extract the following variables: number of employees, industry, union status (sector- or firm-level wage bargaining or no collective agreement), self-rated profitability[10], firm structure (single vs.

[10] The survey question asks for a self-assessment of the profit situation. We construct a three-point scale (high, medium, low) for profitability with well-balanced support over the three categories.

multi-plant firms), and residence (domestic or foreign) of the owner.

In addition to the establishment-level information, the dataset contains information on all employees in the sampled establishments. This includes between 1.6 and 2.0 million workers (corresponding to about 6% of all workers) per year. The employee data is taken from the administrative employment register of the German Federal Employment Agency (*Bundesagentur für Arbeit*) covering all employees paying social security contributions (Bender, Haas and Klose, 2000). While civil servants, self-employed individuals and students are not observed in the social security data, the dataset covers more than 80% of all employed persons in Germany. The employee information is recorded on June 30th of each year and includes information on wages, age, gender, occupation, employment type (full-time or part-time employment) and skill.

Importantly, wages are right-censored at the ceiling for social security contributions (63,400 euros in 2008 for Western Germany). Up to 13% of the observations are censored (see Appendix Table C.4 for the distribution of censored workers across firms). Note that the censoring does not affect our baseline results at the firm-level since we use the median wage in the establishment as our left-hand-side variable. At the individual level, we opt for a conservative approach and assign censored individuals the cap, leading to an underestimation of the wage effect.

2.4 Sample definition and descriptive statistics

We select a ten-year panel of the administrative wage data spanning the years 1999 to 2008 for our analysis. This choice yields a sufficient number of years before and after tax changes, which are necessary to set up the event study design with a window running from four years prior to five years after the reform, implying that we need tax data from 1993 (the first year available to us) until 2012 (see Section 3 for details on the empirical model). Furthermore, ending in 2008 avoids potential wage effects of the Great Recession.

As discussed in Section 2.2, we focus on the 10,001 municipalities that did not change jurisdictional borders between 1993 and 2012. In the LIAB data, we observe firms in 3,522 of those non-merged municipalities. This leaves us with 6,802 tax changes to identify the effect of corporate taxes on wages. Figure 2 shows the distribution of these changes. The left panel shows all non-merged municipalities, while the panel on the right-hand side is based on the non-merged municipalities represented in our estimation sample. The figure shows that tax rate variation in both samples is very similar. In both samples, 93% of the tax changes are increases (see, also, Tables C.2 and C.3, for more details on the (similarity of the) tax rate variation).[11] The mean increase of τ_{LBT} is 0.9

[11] Given the international trend towards lower corporate tax rates this seems surprising. Yet, both

percentage points (or 5%) and the 75th percentile of the tax increase distribution is equal to 1.1 percentage points (6%). We are therefore able to exploit many and fairly large tax reforms for identification.[12]

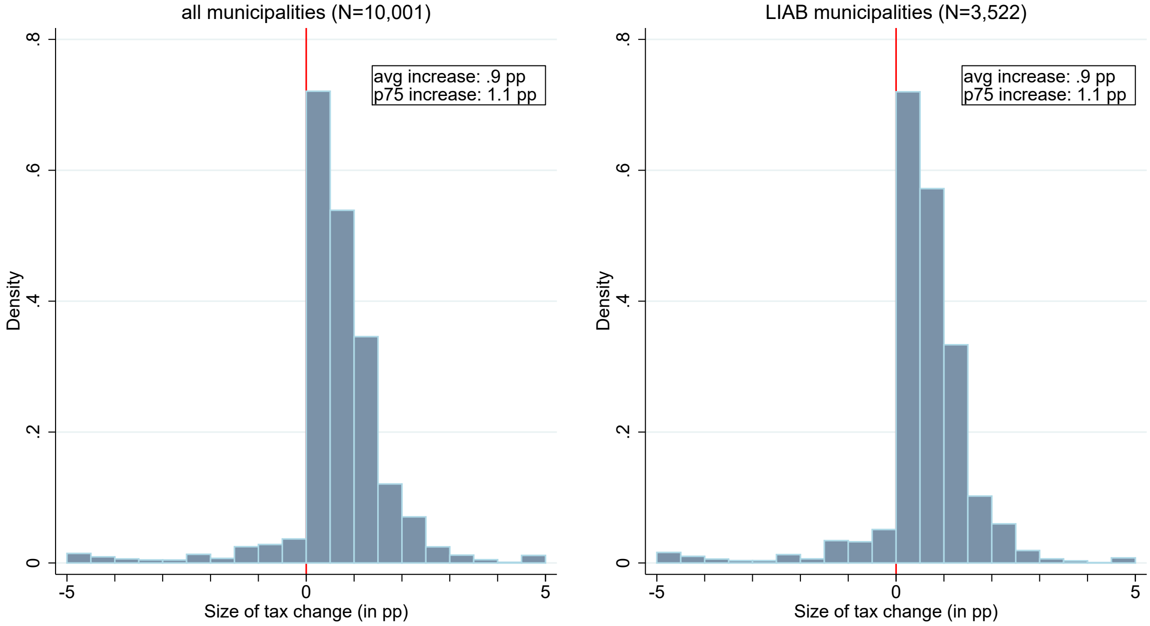


Figure 2: Distribution of local business tax changes

Source: Statistical Offices of the Laender. *Notes:* The histogram shows the distribution of changes in the LBT rate induced by changes of the municipal scaling factor from 1993 to 2012 in non-merged municipalities. In the left panel, the sample consists of all 17,999 tax rate changes in the 10,001 non-merged municipalities, while in the right panel it is constrained to the 6,802 tax changes in those 3,522 non-merged municipalities represented in the linked employer-employee data (LIAB). In both histograms, we omit 0.1% of the observations with absolute changes larger than 5 percentage points for illustrative purposes. The average LBT rate in the full (LIAB) sample is 16.0% (18.7%).

Our estimation sample consist of all firms in non-merged municipalities observed in the LIAB data and their corresponding workers. We exclude the few firms that changed their incorporation status during the observation period from the baseline since such a change simultaneously affects the LBT tax base, the applicable business tax at the federal level (see Appendix B.1) and potentially other firm characteristics such as firm scale or collective bargaining agreements. We also focus on firms with more than three workers to be able to calculate meaningful and reliable wage measures at the firm level. We check the

the federal CIT rate and the top PIT rate decreased in Germany over the period 1993–2012 so that the overall business tax rate declined as well (see Appendix B.1 for more details). Thus, a rise in the LBT rates in a municipality over time has to be seen as leading to a *slower decrease* in the overall tax burden for firms in these municipalities compared to firms in jurisdictions with constant local tax rates.

[12] For instance, Suárez Serrato and Zidar (2016) exploit about 100 corporate tax changes of U.S. states with an average change (over 10 years) of 1% (and about 20% of changes larger than 2%). Part of their variation stems from tax base differences for example due to different apportionment rules. Suárez Serrato and Zidar (2017) document that tax base rules explain more of the U.S. state corporate tax variation than tax rates do.

sensitivity of our results with respect to these sample selection choices below. Appendix Tables C.5 and C.6 present descriptive statistics of our establishment and worker level sample in non-merged municipalities.[13] Table C.5 shows that the average median firm wage is 2,733 euros per month. The average θ^{mun}_{LBT} is 3.85, and the average τ_{LBT} is 18.7%. The average (median) establishment has 265 (53) employees. 64% of the establishments are liable to the LBT. Our baseline estimates presented below will be based on the sample of liable firms, while we use the sample of non-liable firms for a sensitivity check.

Moreover, the descriptive statistics reveal that 62% of the establishments are single-plant firms. More than half of the firms have sector-level bargaining agreements in place, while about a third have no collective bargaining agreement. The descriptive statistics of the individual worker sample (see Table C.6) place greater weight on larger firms with more employees. As larger firms pay higher wages, we see that the median wage in the individual level sample increases to 3,363 euros per month. In terms of individual characteristics, the table shows that the average worker in our sample is 41 years old. The share of males is 72%. 14% of the individuals are high-skilled, while about as many are low-skilled.[14] 81% of the individuals have never earned a wage higher than the social security contribution ceiling in our sample.

3 Empirical strategy

3.1 Research design and identification

We use different empirical models to estimate the causal effect of LBT changes on wages. Our baseline outcome variable is the log median real full-time wage in firm f, located in municipality m, which is part of commuting zone (CZ) c and state s, in year t, $w^{p50}_{f(m,c,s),t}$.[15] We choose the median as the baseline on the firm level to account for the top-coding of wages at the ceiling for social security contributions (see the discussion in Section 2.3).

We start our analysis using an event study design, which formally reads:

$$\ln w^{p50}_{f,t} = \sum_{j=-4}^{5} \gamma_j D^j_{m,t} + \mu_f + \mu_m + \psi_{s,t} + \varepsilon_{f,t}. \tag{1}$$

The independent variables of interest are a set of dummies $D^j_{m,t}$ indicating an event

[13] In the baseline, we only consider full-time workers. We also looked at the effects on part-time wages but found no significant differences (see below).

[14] We differentiate between three skill groups: high-skilled workers who have obtained a college/university degree; medium-skilled who have completed either vocational training or the highest high school diploma (*Abitur*); low-skilled who have completed neither of the two.

[15] In order to ease notation, we only include the index of the lowest geographical level in the following.

happening j periods away. Following Simon (2016), we estimate different specifications, where events are either (i) any LBT increase, (ii) large tax increases, or (iii) tax decreases. Large increases are defined as any tax hike greater than or equal to the 75th percentile of the tax increase distribution. There are two potential advantages of focusing on large increases. First, wages might not respond to small tax rate changes, e.g. due to adjustment costs. Second, we limit the number of events per firm and reduce the likelihood that other tax events happened within the event window (Simon, 2016). As an additional sensitivity check, we estimate the model on a restricted sample of tax changes that have no other changes in the event window. We set a baseline event window, running from 4 years prior to a tax change to 5 years after.[16] In addition, we include firm, (μ_f), and municipal, (μ_m), fixed effects.[17] To account for regional shocks, our baseline specification includes "state $\times$ year" fixed effects ($\psi_{s,t}$). The error term is denoted by $\varepsilon_{f,t}$.

The event study specification uses dummy variables to capture tax rate changes. In order to account for different magnitudes of tax changes, we follow Suárez Serrato and Zidar (2016) and estimate the following distributed lag model:

$$\ln w_{f,t}^{p50} - \ln w_{f,t-1}^{p50} = \sum_{j=-4}^{5} \beta_j [\ln(1 - \tau_{m,t-j}) - \ln(1 - \tau_{m,t-1-j})] + \psi_{s,t} + \varepsilon_{f,t}. \qquad (2)$$

We regress the annual change in log wages on the change in the log net-of-business-tax rate. The estimated coefficients $\hat{\beta}_j$ measure the effect of leads and lags of a tax rate change on the annual real wage growth. Time invariant factors are differenced out. We use the estimates of the model to calculate the cumulative effect of a tax change.

In both models (1) and (2), identification is achieved within firms and municipalities over time, and we thus estimate variants of a DiD model with fixed effects. Identification of causal effects in such models requires common trends pre-treatment – that is, no statistically significant wage responses preceding a tax reform. While we use specifications (1) and (2) mainly to establish flat pre-trends, we use the following generalized DiD model to estimate the average effect of a change in the LBT rate on wages relative to the pre-treatment period, which we then use to calculate the tax incidence:

$$\ln w_{f,t}^{p50} = \delta \ln(1 - \tau_{m,t}) + \mu_f + \mu_m + \psi_{s,t} + \varepsilon_{f,t}, \qquad (3)$$

[16] We experimented with different leads and lags, but results are robust to the event window definition. As commonly done, we bin up event dummies at the endpoints of the event window (i.e., $j = -4$ and $j = 5$). Hence, the dummy $D_{m,t}^{5}$ accounts for all reforms occurring five or more years ago (McCrary, 2007). This is necessary as we have a balanced panel in terms of years (1993-2012), but reform years differ across municipalities, which yields an unbalanced panel in event time. Because of this, we do not plot the endpoint estimates in the event study graphs.

[17] Firm and municipal fixed effects are highly collinear as only very few firms move between municipalities in the data.

where δ measures the percent change in wages induced by a one percent increase in the net-of-tax rate.

Given flat pre-trends, our research design would still be invalid if local shocks systematically affected tax rates and wages. We provide three further checks to assess whether such potential local shocks are likely to bias our estimates. First, we run event study designs as specified in equation (1) using GDP, unemployment, as well as municipal revenues and spending as outcome variables. Significant pre-treatment trends for these outcomes would hint at local shocks and cast doubt on our identifying assumption. As will be shown in Section 4, there are no local shocks to the business cycle prior to a tax change. Second, we further test the sensitivity of the empirical models with respect to local shocks. While our baseline specifications include "state $\times$ year" fixed effects, which non-parametrically account for local shocks at the state level, we can control for shocks at different levels of aggregation. We estimate a simpler model using only year fixed effects and a more complex model with "commuting zone $\times$ year" fixed effects (there are 258 CZ in Germany). If confounding local labor market shocks were important, estimates should vary across different specifications since they should be picked up at least partly by "CZ $\times$ year" fixed effects. Third, besides these non-parametric specifications, we directly account for local time-varying confounders by additionally controlling for (lagged) GDP, unemployment, population, and municipal spending. As will be shown below, our results are robust to these tests for omitted confounders.

Heterogeneous effects. In order to test for heterogeneous effects, we interact the local tax rates in the DiD models with firm or worker characteristics. Some of these characteristics such as wage setting institutions are potentially endogenous to the tax rate. For this reason, we fix the characteristics to the values of 1997, i.e., two years prior to our first panel observation. Heterogeneous firm effects are estimated at the firm level, and worker effects at the individual level. In terms of controls, the models include municipal, firm, "state $\times$ year" fixed effects (cf. model (3)) and additionally "firm/worker type $\times$ year" fixed effects. On the worker level, the outcome variable is the log individual wage, and we additionaly include worker fixed effects.

Inference. In our baseline approach, we cluster standard errors at the municipal level, i.e. the level of our identifying variation. Given the well-known problems of biased standard errors in differences-in-differences models (Bertrand, Duflo and Mullainathan, 2004), we conduct two tests to assess the sensitivity of our estimates: First, we aggregate the data to the municipal level, finding similar results. Second, we follow the suggestions by Angrist and Pischke (2009) to "pass the buck up one level" and cluster standard errors on a higher level of aggregation, which in our case is the county or the commuting zone. As will be shown below, standard errors of estimates are hardly affected.

3.2 Measuring the tax incidence

The DID estimate from equation (3) measures the elasticity of the wage rate with respect to the net-of-business tax rate, $\hat{\delta} = \frac{dw}{d(1-\tau)} \frac{(1-\tau)}{w}$. We can use this estimate to calculate the incidence of corporate taxes on wages as the share of the total business tax burden falling on workers. We do so by relating the welfare change of workers induced by a marginal change in the net-of-tax rate to the sum of the welfare changes of workers and firm owners (see Suárez Serrato and Zidar, 2016).

Assume that worker i in municipality c maximizes utility $U(C, L)$ over consumption C and leisure L, subject to the budget constraint $C = w(1-t)L$, where t is the personal income tax rate and L the quantity of labor.[18] The indirect utility function can be written as $V((1-t)w)$ and the change in worker utility induced by a change in the wage rate is given by $dV = L(1-t)dw$. A representative firm j faces a corporate tax rate τ and maximizes profits, $\Pi = (1-\tau)[F(K,L) - wL] - (1-\alpha\tau)rK$, over capital K and labor L. The tax base T is given by $T = F(K,L) - wL - \alpha rK$, where α is the share of deductible capital costs. By the envelope theorem, the change in welfare for firm owners is given by $d\Pi = -d\tau T - dwL(1-\tau)$. The share of workers in the overall burden of a marginal change in the corporate tax rate is given by $I^w = \frac{dV}{dV + d\Pi}$. Plugging in our estimate of $\hat{\delta}$ and rearranging, the share of workers in the tax burden can be written as:

$$I^w = \frac{wL\hat{\delta}(1-t)}{(1-\tau)T - wL\hat{\delta}(t-\tau)}. \tag{4}$$

Equation (4) measures the incidence of corporate taxation on wages. As in Suárez Serrato and Zidar (2016), the wage elasticity with respect to the net of tax rate is a sufficient statistic to calculate marginal welfare changes of both workers and firms.[19] It would also be interesting to look at responses in input factors or output. This would allow us to calculate the excess burden of the corporate income tax. However, given that the necessary information is either incomplete (output) or not available (capital) in our administrative wage data (see Section 2.3) and given that linking another dataset to our data is not possible, addressing these questions is beyond the scope of this paper.

[18] We omit indices for readability. For notational simplicity, we assume quasilinear preferences and normalize the marginal utility of income to unity.

[19] This approach relies on simplifying assumptions. In particular, all agents are price takers, that is, imperfect competition in input and output markets is not taken into account, and the measure abstracts from heterogeneity of firms and workers.

4 Baseline results

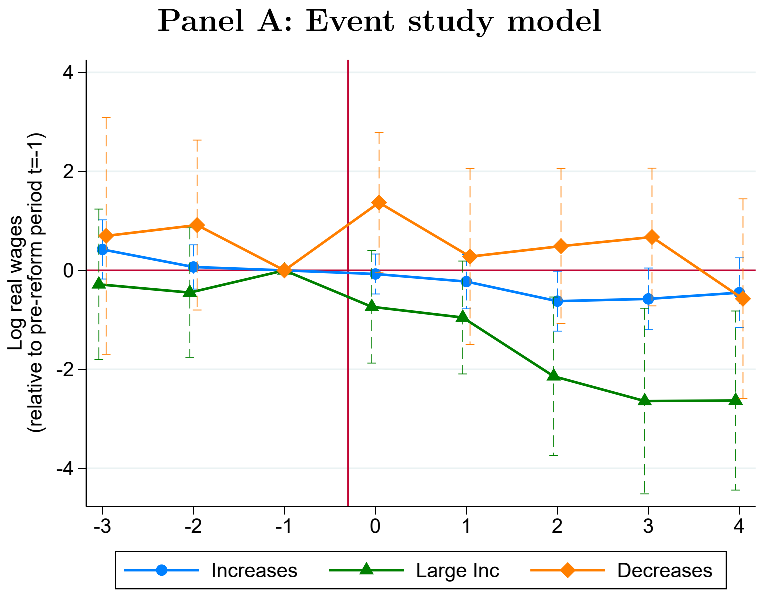
We start our analysis of the wage effects of the LBT by plotting the event study estimates from equation (1) in Panel A of Figure 3 for three different specifications: any increase, large increases, and any decrease. Given the 0-1-event dummy definition, we exclude tax decreases (increases) from the sample used to estimate the effect of tax increases (decreases).[20] We find a negative and significant effect of business tax increases on real wages. We hardly observe any decline in nominal wages in our data but find slower wage growth in affected firms over time, leading to lower levels in the future. Reassuringly, wage effects become stronger when focusing on the 25% largest tax increases. Estimates for tax decreases (which are relatively rare - cf. Figure 2) are noisy and inconclusive. The point estimates hint at a slight yet insignificant pre-trend. In the sensitivity checks below, we show that municipalities with tax decreases are not driving our results.

In order to exploit the different sizes of tax changes, we plot the cumulative effects of the distributed lag model (equation (2)) in Panel B of Figure 3. The higher the *net-of-tax rate* increase, the higher the wage growth. Hence, the results of the event study are confirmed as a tax increase implies a decrease in the net-of-tax rate. Including four leads of the change in the log net-of-tax rate, we again find a flat pre-trend. The model plotted in Panel B is estimated on the same sample of municipalities to allow for comparisons to Panel A. Appendix Figure D.3 shows a similar pattern when including all municipalities.

A remaining concern in our setting is that tax rates might respond to local business cycle shocks, which could also affect wages. We can test directly for violations of the identifying assumptions by using local economic outcomes as left-hand-side variables in the event study design. Figure 4 shows the results for GDP and unemployment. Investigating the pre-treatment periods, we find flat pre-trends for our specifications using (large) tax increases.[21] We find similar patterns when looking at municipal revenues and spending (see Appendix Figure D.5). For tax decreases, we find again pre-trends for GDP but not unemployment (see Appendix Figure D.4).

[20] We also estimated the model on other sample definitions: (i) no restriction, (ii) zero decreases and only one increase in event window, (iii) zero decreases and only one increase in the sample. Appendix Figure D.1 shows that those kinds of sample restrictions are not driving our results.

[21] This is in line with previous evidence for the German LBT (Foremny and Riedel, 2014) as well as for income tax reforms in Europe (Castanheira, Nicodème and Profeta, 2012), which suggests that tax changes are typically triggered by political factors, not shocks on economic variables.



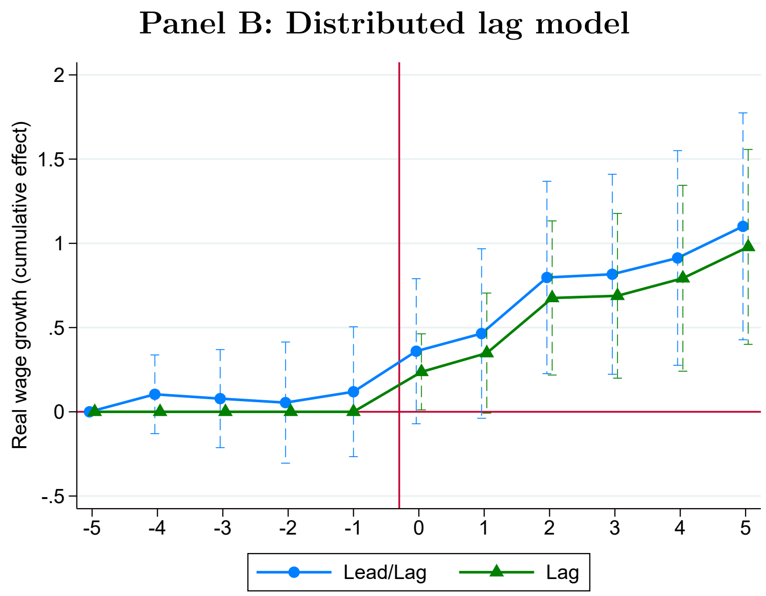


Figure 3: Baseline wage effects

Source: LIAB and Statistical Offices of the Laender. *Notes:* Panel A plots event study estimates ($\hat{\gamma}_j, j \in [-3, 4]$) and corresponding 95% confidence bands of different specifications of equation (1). Dependent variable is the log median firm wage (observed on 30 June for each year). Event variables are dummies equal to one for a tax increase, a large tax increase (greater than or equal to the 75th percentile of the tax increase distribution), or a tax decrease (see legend). The estimation sample comprises all establishments liable to the LBT in non-merged municipalities. In specifications with tax increase (decrease) dummies, we exclude all municipalities that experienced a tax decrease (increase) during the observation period. Panel B plots distributed lag model estimates ($\hat{\beta}_j, j \in [-4, 5]$) and corresponding 95% confidence bands of different specifications of equation (2). Dependent variable is the yearly change in the log median firm wage. Depending on the specification, main regressors are lags or leads and leads of the yearly change in the net-of-local-business-tax rate (see legend). Note that a tax increase in the event study design in Panel A implies a decrease in the net-of-tax rate in Panel B. The estimation sample comprises all establishments liable to the LBT in non-merged municipalities that did not experience a tax decrease during the observation period. In both panels, the tax change occurred for the treatment group on 1 January in event year $t = 0$, as indicated by the vertical red line. All regression models include municipal, firm and "state × year" fixed effects. Standard errors are clustered at the municipal level. Estimates are reported in Tables D.10 and D.13.

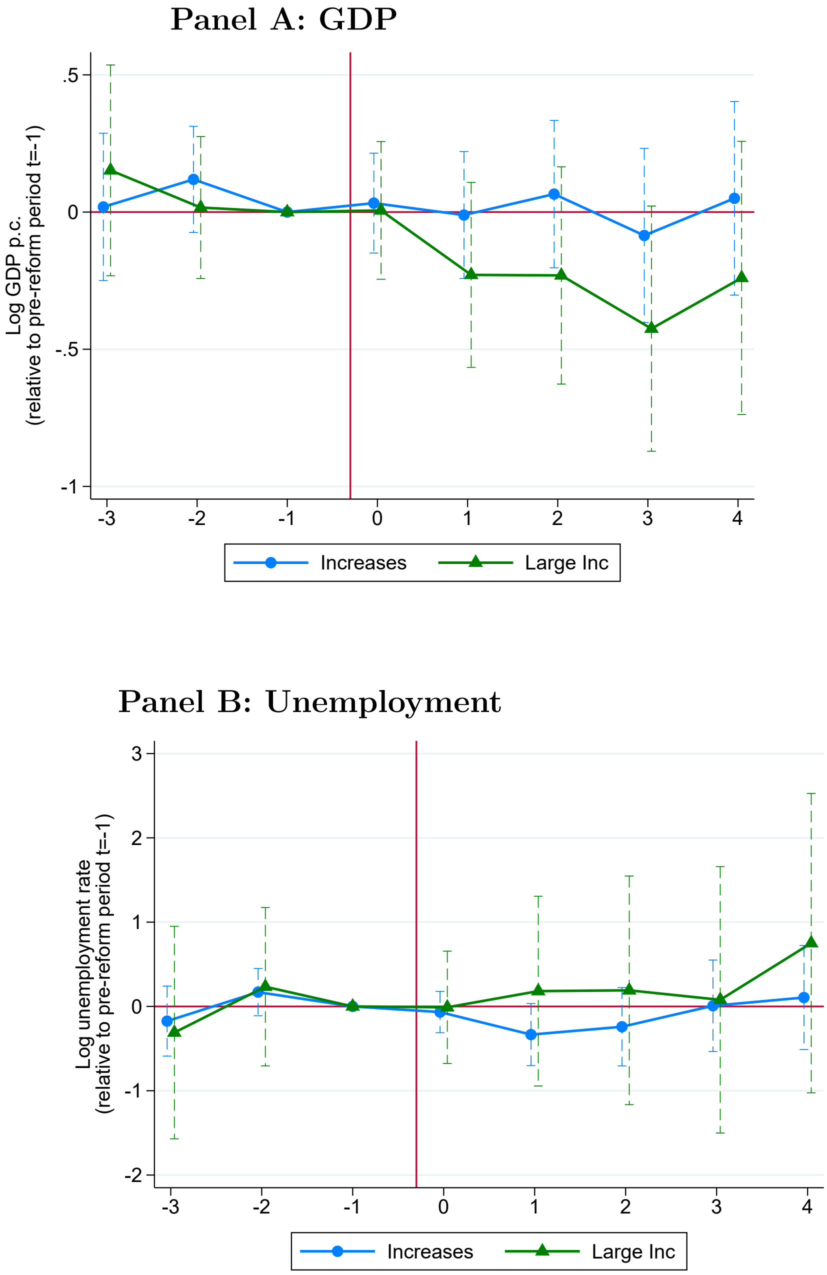


Figure 4: Event study graphs: local business cycle effects

Source: Statistical Offices of the Laender. *Notes:* The graph plots event study estimates ($\hat{\gamma}_j, j \in [-3, 4]$) and corresponding 95% confidence bands of different specifications of equation (1). Dependent variables are log county GDP per capita (Panel A) and unemployment rate (Panel B). Event variables are dummies equal to one for a tax increase or a large tax increase (greater than or equal to the 75th percentile of the tax increase distribution, see legend). The tax change occurred for the treatment group on 1 January in event year $t = 0$, as indicated by the vertical red line. All regression models include municipal and "state $\times$ year" fixed effects. The estimation sample comprises all non-merged municipalities from the LIAB data that did not experience a tax decrease during the observation period. Standard errors are clustered at the municipal level. For corresponding event study graphs including tax decrease specifications, see Figure D.4. Estimates are reported in Tables D.15 and D.16, respectively.

While we use the graphical representation of the event study and distributed lag specifications mainly to establish flat pre-trends, we use the DiD model given by equation (3) to estimate the average effect of a change in the LBT on wages. The baseline elasticity for liable firms is provided in column (1) of Table 1. A one percent decline in the net-of-tax rate (reflecting an increase in the tax rate) reduces wages by 0.39 percent. Applying formula (4), we can calculate the share of the tax burden borne by workers as a measure of tax incidence. We find that 51% of the corporate tax burden is passed onto workers.

Table 1: Differences-in-differences estimates: baseline wage effects

	(1)	(2)	(3)	(4)	(5)	(6)
Log net-of-LBT rate	0.388	0.229	0.386	0.396	0.343	0.399
	(0.127)	(0.110)	(0.127)	(0.128)	(0.164)	(0.118)
Incidence (I^w)	0.505	0.288	0.502	0.516	0.442	0.520
	(0.170)	(0.140)	(0.170)	(0.172)	(0.217)	(0.159)
State × year FE	✓			✓	✓	✓
Year FE		✓				
CZ × year FE			✓			
Municipal controls $t-2$				✓		
Firm controls $t-2$					✓	
Worker shares						✓
Observations	44,654	44,654	44,654	44,654	25,241	44,654

Source: LIAB and Statistical Offices of the Laender. *Notes:* This table presents the DiD estimates, $\hat{\delta}$, of regression model (3) at the firm level. Coefficients measure the wage elasticity with respect to the net-of-local-business-tax rate. The incidence effect I^w is measured according to formula (4) as the share of the total tax burden borne by workers. All regression models include municipal and firm fixed effects. Additional control variables and fixed effects (year, "state × year" or "commuting zone (CZ) × year") vary depending on the specification (as indicated at the bottom of the table). The estimation sample is restricted to all establishments liable to the LBT in non-merged municipalities. Standard errors are clustered at the municipal level. Corresponding standard errors for the incidence measure are obtained using the Delta method. Our preferred (baseline) specification is shown in column (1).

Sensitivity checks. We run a set of sensitivity checks testing whether our estimates are driven by modeling choices. We start with further tests of the robustness of our estimates with respect to unobserved local shocks. The baseline specification includes "state × year" fixed effects to non-parametrically account for shocks at the state level. We estimate various specifications where we vary the set of control variables, replacing "state × year" with more aggregated year fixed effects or more disaggregated "commuting zone (CZ) × year" fixed effects. We also estimate specifications where we add local controls (GDP, unemployment, spending, population) and firm controls (employment) to the model, capturing the local business cycle.[22] If local shocks were important, estimates should vary across different specifications. Yet, the results reported in Table 1 are robust. In particular, estimates are unchanged when moving from the baseline to the very rich specification with CZ-year fixed effects.

While our baseline results are estimated at the firm level, we also estimated the DiD model at the municipal and individual level (cf. Appendix Table D.1). While estimates are a bit noisier on the municipal level due to smaller numbers of observations, point estimates are reassuringly similar at all three levels of aggregation.

In our baseline specification, the dependent variable is the median wage in the firm. We chose this measure to account for the right-censoring of the data, which would bias our estimates toward zero.[23] Nevertheless, we conduct several additional checks to assess the implications of this choice. First, we check that results are not driven by the composition of the workforce and hence by a change in the median worker. Specification (6) in Table 1 shows that estimates are hardly affected when controlling for various worker shares (age, gender, skill, occupation and employment type) at the firm level. This is confirmed by a second test where we estimate the DiD model using the different worker shares as dependent variables. Results are shown in Appendix Table D.2 and reveal that the worker composition does not react to changes in the tax rate. Estimates are insignificant and/or very small. Third, and in line with the predicted bias toward zero, specification (3) of Table D.3 shows that the wage effect increases when controlling for the share of never-censored workers at the firm level. Similarly, we find that wage effects are stronger for firms with fewer censored workers. Last, we estimate the DiD model at the worker level and exclude all individuals who at least once earned a wage above the contribution ceiling during the observation period. Again, we find that estimates increase when excluding censored workers (see column (7) of Table D.6 as well as Table D.8).[24]

We also test the sensitivity with respect to sample restrictions (cf. Appendix Table D.5). Our DiD baseline sample comprises firms liable to the LBT in municipalities that

[22] All control variables are in logs and lagged by two periods to reduce endogeneity issues; results are similar when using contemporaneous variables.

[23] If all workers earned above the contribution ceiling, we would not be able to observe any wage change in the data and hence estimate a zero wage effect. However, in our data, the median worker in almost all firms earns a wage below the cap for social security contributions (see Table C.4). We also estimated model (3) using different wage measures as left-hand side variables (cf. Appendix Table D.4). When using the mean wage on the firm level (instead of the median), we find smaller yet still significant wage effects. Moreover, we find that wages for the top 25% of workers across firms respond less. We discuss potential distributional implications in more detail below.

[24] Imputing censored wages would be another option used in the literature (Dustmann, Ludsteck and Schoenberg, 2009; Card, Heining and Kline, 2013). While this is sensible when analyzing wage inequality, it is problematic in our setting since the LBT rate would have to be included in both the selection equation and the second stage equation.

never merged with other municipalities and never experienced a tax decrease during the observation period. We find smaller but still significant effects when adding tax-exempt firms to the baseline sample (see also the discussion in Section 5.2). Likewise, estimates decrease when adding the merged municipalities to the sample. In column (4) of Table D.5, we restrict the sample to municipalities without a tax decrease during the observation period to rule out that those decreases are driving the results. DiD estimates increase slightly, which suggests that potential endogeneity would bias our estimates downward. In columns (5) and (6), we add firms that switched their incorporation status and firms with less than four workers to the estimation sample (cf. Section 2.4). In both cases, the wage elasticity increases a bit. In 2008, the basic federal rate of the LBT was reduced from 5 to 3.5% and deductibility of the tax payment itself was abolished (see Section 2.1). Results are robust to dropping this year from the sample (column 7).

Finally, we show that standard errors hardly change when clustering at higher aggregation levels than municipalities such as counties or commuting zones (see Appendix Table D.7). These findings are in line with the results that we get when estimating the model on different levels of aggregation (Table D.1).

5 Theoretical mechanisms and heterogeneous effects

We have established that workers on average bear half of the corporate tax burden. In this section, we analyze the economic forces driving this effect. We start with a brief discussion of different theoretical models of corporate tax incidence and the wage effects they predict (see Appendix A for the full theoretical analysis). In a second step, we exploit the rich firm and worker level information in our data to investigate the predictions of the different theories.

5.1 Theoretical predictions

In his seminal paper on corporate tax incidence, Harberger (1962) considers a closed economy with a corporate and a non-corporate sector. In his setting, the burden of corporate taxes is borne entirely by capital. The subsequent literature has emphasized the importance of international capital mobility. In open economies, higher corporate taxes reduce domestic investment, and wages decline.[25]

In this paper, we study the effects of a local business tax. In this setting labor is

[25] See, e.g., Bradford (1978); Kotlikoff and Summers (1987). In these models, the share of the (source-based) corporate tax burden borne by domestic immobile factors increases as the size of the economy relative to the rest of the world decreases. See Auerbach (2006), Harberger (2006) and Gravelle (2013) for surveys of the literature.

arguably more mobile across jurisdictional borders than internationally. In the polar case of perfect worker mobility, local corporate tax changes should not affect wages because they are determined in the national labor market.[26] Yet, even at the local level, mobility is likely to be imperfect, and it may differ across workers.

Even with perfect worker mobility, Tiebout (1956)-type models would predict negative wage responses to local corporate tax increases because migration decisions may depend on local public services. If the additional revenue raised is spent on local public services, workers may accept lower local wages. An implication of the Tiebout model is that wages would also decline in tax-exempt firms if the local tax rate increases.

The models discussed so far are based on the assumption of competitive product and labor markets. If products (or consumers) are costlessly mobile across jurisdictions, firms cannot shift the burden onto their customers. This implies that other shifting channels must be more relevant. Given that we look at a local tax, we expect the pass-through on consumer prices to be of second order. Nevertheless, the incidence on wages might be higher for industries that produce more tradable goods.

Relaxing the assumption of perfectly competitive labor markets, we show in Appendix A that most models with labor market frictions also predict that higher corporate taxes reduce wages. The mechanisms at work are, however, different, and the magnitude of the effects depends on wage setting institutions. We will briefly discuss the key insights from these models in the following paragraphs.

In collective bargaining models, workers receive a share of the surplus generated by the firm. If higher corporate taxes reduce this surplus, workers bear part of the burden.[27] The level at which employers and unions bargain over wages is important. Local taxes can be expected to have the strongest impact on wages if bargaining is at the firm level, and the firm operates in one jurisdiction only. If wages are set at the sector level, the impact of a tax change in one jurisdiction will decrease with the number of jurisdictions where the sector is present. Similarly, if a firm operates plants in multiple jurisdictions, a tax change in one may not matter much – even if wages are set at the firm level.

Fair wage models (Akerlof and Yellen, 1990; Amiti and Davis, 2010) also imply that higher corporate taxes reduce wages. In some variants, wages are directly related to after tax profits. In other efficiency wage models, such as shirking models (Solow, 1979; Shapiro and Stiglitz, 1984), the optimal wage trades off higher output against the cost of

[26] Along the same lines, a standard assumption is that output prices are determined in national markets for goods and services so that the tax burden cannot be shifted onto consumers.

[27] The rent accruing to the workers declines, but how this is translated into changes in employment and wages is theoretically ambiguous. If employment is constant or increases, wages decline unambiguously. However, it is theoretically possible that employment declines by so much that wages increase although the overall rent accruing to workers falls.

higher wages.[28] If wage setting in tax-exempt firms considers wages in taxable firms as a reference for fairness, the prediction would be that wages in tax-exempt firms are also affected by tax changes.

In monopsonistic labor markets where firms have wage setting power, higher corporate taxes also reduce wages. The magnitude of the effect depends on the degree of market power. Firms with a lot of market power will pay lower wages. This implies little room for wages to fall in response to higher corporate taxes and consequently smaller wage effects in firms dominating the local labor market.

Another factor that may affect the incidence of corporate taxes is income shifting to avoid taxes. Large, multi-plant and in particular foreign-owned firms can avoid taxes by shifting profits across jurisdictions or even abroad. If this is relevant, we should observe smaller effects of tax changes for these firms.

Table 2: Wage effects of a local corporate tax under different theoretical models

Model	**Main mechanism**	**Predicted wage effect**	**Empirical findings**
Harberger-type model w/ open economy	Mobility of production factors determines incidence	Larger wage effect for less mobile workers	✓
Tiebout sorting	Tax revenues increase public good quality, which leads to compensating wage differential	Wage effects smaller conditional on future municipal spending	–
		Wages in non-liable firms should decline	–
Additional pass-through opportunities	If alternative pass-through opportunities exist, wage channel becomes less important	Wage effects higher in sectors that produce more tradable goods	✓
Collective bargaining	Tax reduces rent to be split between firms and workers, reducing wages c.p. Overall effect depends on employment response.	Negative wage effect for plants with CBA	✓
	Sector-level bargaining dilutes rent effect of *local* tax if sector present in many jurisdictions	Smaller wage effect for plants with sector-level CBA compared to plants with firm-level CBA	✓
Fair/efficiency wages	Wage depends on profits and/or reference wages	Stronger wage decline in more profitable firms	✓
		Wages in non-liable firms should decline	–
Monopsony power	Firms with market power pay lower wages given little room for shifting of corporate tax burden	Effects smaller in firms with higher regional labor market power	✓
Income shifting	Firms may shift profits to different jurisdiction or abroad	Smaller effect for multi-establishment firms	✓
		Smaller effect for foreign-owned firms	✓

[28] Here, higher corporate taxes decrease investment and therefore reduce the marginal productivity gain from a wage increase. Consequently, wages fall when corporate taxes increase. A similar mechanism is at play in directed search models, where higher wages affected productivity through better worker-firm matches (Acemoglu and Shimer, 1999).

In Table 2, we summarize the different theoretical mechanisms and the predicted wage effects. We can shed light on the relevance of these theories by testing their main assumptions and mechanisms using the rich linked employer-employee data. The last column of Table 2 provides a preview of our empirical findings.

5.2 Empirical tests

In this subsection, we investigate the empirical relevance of the different theories discussed in the preceding section. As different mechanisms may be at play simultaneously, it is difficult (if not impossible) to single out specific channels empirically.[29] Nonetheless, the rich linked employer-employee data allows us to zoom in on central implications of the different theories and test their relevance, assuming that other characteristics are given. We test the different theoretical predictions by interacting the net-of-tax rate from the DiD model (3) with pre-determined indicators for specific firm or worker types.

Firm-level heterogeneity. The firm-level results are presented in Table 3. We start by testing whether tax-exempt firms also respond to tax rate changes.[30] We find a negative but insignificant point estimate for tax-exempt firms.[31] This result suggests that Tiebout sorting mechanisms do not play a major role in the German context. In line with this assertion, we find that estimates do not change when we include current and future municipal spending as additional control variables (see column (3) of Table D.3). Instead, the negative point estimate suggests that the higher tax burden on other firms might give tax-exempt firms a competitive advantage, boosting their wages.

Next, we test for differences by industry. Empirically, we find larger and significant effects only for manufacturing and construction sector firms. One explanation for the difference to trade and service sector firms could be that the latter are able to shift part of the burden to their customers as their products and services are on average less tradable than manufacturing goods.

Next, we investigate the interaction of tax rates and different wage-setting institu-

[29] For instance, a large multi-plant firm might be more profitable than others. Consequently, it may be able to shift income abroad. At the same time, wages may be set via collective bargaining at the firm level. In order to isolate and test a specific theory, e.g., union bargaining, we would need exogenous (and exclusive) variation in the bargaining status of the firm.

[30] In the absence of any spill-overs, we could estimate a triple-difference model. The resulting treatment effect, which would equal the difference between the two DiD estimates for liable and non-liable firms, would be larger.

[31] When considering all firms, column (2) of Table D.3 shows that the average worker in Germany bears 22% of the LBT instead of 51% in liable firms. This is confirmed when estimating the event study design for liable vs. non-liable firms (see Appendix Figure D.2).

tions.[32] We start by estimating heterogeneous effects by collective bargaining agreement (CBA) of the firm. We group firms into three categories: firms with (i) a sector-level CBA; (ii) a firm-level CBA; (iii) no CBA. Overall, we find larger wage effects for firms under collective bargaining. In line with the theoretical predictions, we find that the incidence effects for firm-level bargaining are stronger than for sector-level CBA. We also find wage responses for firms without CBA but they are smaller and not significant. Another striking empirical pattern is that effects are increasing in firm profitability. This is in line with collective bargaining models, but also many other labor market theories, where rents are split between firms and workers, for instance fair wage models.

When stratifying the results by firm size, we find that the wage effect is driven by small and medium sized firms, which account for more than 95% of all firms in Germany (and employ about two-thirds of the workers). Taking a closer look, we also find significant wage effects for larger and profitable manufacturing firms with up to 500 employees. These firms (the so-called *"Mittelstand"*) are often considered to be the backbone of the German economy, with many 'hidden champions' (Simon, 2009). Our results suggest that workers in these companies are more affected by local corporate tax changes than employees of very large firms. One reason for this finding may be local wage setting power of larger firms, as suggested by monoposony models. When interacting the LBT rate with a dummy indicating the size of the firm relative to the local labor market, we indeed find that wages in relatively small firms react more strongly.

Other potential explanations for the insignificant wage effect in large firms include more tax avoidance opportunities or a presence in multiple jurisdictions. Table 3 shows significant wage effects only for single-plant firms, while establishments in multi-plant firms show no wage response. For those firms, tax changes in one jurisdiction might not be relevant enough to influence wages. Another explanation is that multi-plant firms can shift profits to other jurisdictions (nationally and/or internationally). In line with this reasoning, we also find a zero (to be precise, a negative but insignificant) wage effect if a plant has a foreign owner.[33] This supports the theoretical prediction that profit-shifting opportunities dampen effects of local tax changes on wages.

[32] See Appendix B.2 for a brief discussion of labor market institutions in Germany.

[33] Neither the effect for single-plant firms nor for German-owned firms is driven by firm size.

Table 3: Differences-in-differences estimates: wage effects by firm type

Stratified by ...	Effect of log net-of-LBT rate by firm type				N
Liability	Liable	Non-liable			69,249
	0.388	−0.178			
	(0.127)	(0.154)			
Sector	Manuf.	Const.	Trade	Serv.	44,654
	0.556	0.452	0.151	0.383	
	(0.155)	(0.248)	(0.276)	(0.253)	
Collect.-Barg. agreem.	Firm	Sector	None		44,654
	0.731	0.418	0.292		
	(0.351)	(0.127)	(0.239)		
Profitability	High	Medium	Low		43,622
	0.565	0.330	0.210		
	(0.214)	(0.187)	(0.200)		
Firm size (# workers)	Below 10	10 to 99	100 to 499	Above 500	44,654
	1.241	0.311	0.064	−0.212	
	(0.520)	(0.157)	(0.159)	(0.210)	
Size rel. to local labor market (market power)	Small	Medium	Large		44,654
	0.652	0.481	0.456		
	(0.310)	(0.206)	(0.169)		
Firm structure	Single-plant	Multi-plant			44,226
	0.426***	0.223			
	(0.160)	(0.162)			
Ownership	German	Foreign			44,654
	0.449***	−0.293			
	(0.141)	(0.298)			

Source: LIAB and Statistical Offices of the Laender. *Notes:* This table presents the DiD estimates $\hat{\delta}$ of regression model (3) for different types of firms as indicated in the table. The heterogeneous effects are estimated by interacting the LBT rate with dummy variables for different firms types. Coefficients measure the wage elasticity with respect to the net-of-local-business-tax rate. All specifications include firm and municipal fixed effects, as well as “state × year” and “firm type × year” fixed effects. The estimation sample comprises all establishments liable to the LBT in non-merged municipalities.

Worker heterogeneity. We test for worker heterogeneity by estimating model (3) at the individual level. Baseline estimates are similar to results at the firm level and robust to including various control sets (cf. Table D.6).[34] Heterogeneous worker effects are summarized in Table 4.

In our first test, we look at the effect by skill. While effects are similar for medium- and low-skilled workers, we find no wage effect for high-skilled individuals, even if we exclude workers affected by censoring (see Appendix Table D.8). A potential reason for this difference is that high-skilled workers are usually more mobile than low-skilled individuals in Germany (Haas, 2000). An alternative explanation would be that the wage setting process differs across skill levels.[35]

Mobility effects are also a potential explanation for our heterogeneous effects by gender, where we find larger wage effects for women. In Germany, women are often the secondary earner in a couple. This reduces their mobility. We check that gender effects are not driven by differences in industry, occupation, or different work contracts in terms of working hours. In general, wage effects do not change when including part-time workers; see column (8) of Table D.6. When differentiating by broad occupation group, we find a stronger effect for blue-collar workers, in line with the results by industry shown above. Similarly, when stratifying by age, the effect is significantly higher for younger workers.

Our results for heterogeneous types of workers are particularly important for the distributional implications of corporate taxation. We confirm other empirical studies that corporate taxes are not entirely borne by capital, finding that half of the burden is shifted onto wage earners. In addition, more vulnerable worker groups are affected more strongly by changes in corporate tax rates. Both findings reduce the progressivity of business taxes and consequently of the overall tax system.

We assess the implications of our findings for tax progressivity in a back-of-the-envelope calculation. Our starting point is the study on the progressivity of the US tax system by Piketty and Saez (2007). They calculate effective average (personal plus corporate) income tax rates across the income distribution, and measure the progressivity of the tax system by comparing the average tax rate of the top 10% or top 1% to the average tax rate of the bottom 90%. Importantly, they assume that corporate taxes fall

[34] Unlike the analysis at the firm-level, for which we used the median wage as our left-hand-side variable, the observed wage at the individual level might be censored as discussed above. We address this issue by estimating each interaction model for the full sample of all workers and for a subsample excluding individuals who have been above the contribution ceiling at least once. As above, we find that wage effects increase when restricting the sample to never censored workers (see Appendix Table D.8).

[35] More bargaining power of skilled workers is not a sufficient explanation for the observation that wages of this group do not fall in response to higher taxes. Groups with high bargaining power can be expected to capture a high share of the firm's profit ex ante, so that they should suffer larger losses than groups with less bargaining power if corporate taxes increase.

Table 4: Differences-in-differences estimates: wage effects by worker type

Stratified by ...	Effect of log net-of-LBT rate by worker type			N
Skill	High	Medium	Low	9,295,488
	0.013	0.357	0.377	
	(0.120)	(0.115)	(0.168)	
Gender	Female	Male		9,295,488
	0.530	0.325		
	(0.129)	(0.119)		
Occupation	Blue-collar	White-collar		9,295,442
	0.363	0.250		
	(0.132)	(0.104)		
Age	Young	Medium	Old	9,295,488
	0.507	0.317	0.329	
	(0.127)	(0.111)	(0.106)	

Source: LIAB and Statistical Offices of the Laender. *Notes:* This table presents the DiD estimates $\hat{\delta}$ of regression model (3) with the log individual wage as dependent variables for different worker types as indicated in the table. The heterogeneous effects are estimated by interacting the LBT rate with dummy variables for different firms types. Coefficients measure the wage elasticity with respect to the net-of-local-business-tax rate. All specifications include worker, firm and municipal fixed effects, as well as "state × year" and "worker type × year" fixed effects. The estimation sample comprises all establishments liable to the LBT in non-merged municipalities. Standard errors are clustered at the municipal level.

entirely on capital income. We take their data and estimates as a benchmark for the US and use comparable data compiled by Bach, Beznoska and Steiner (2016) for Germany. We then compute two counterfactuals where 50% (or 100%) of corporate taxes fall on wages. Calculations are reported in Appendix Table D.9.[36] The ratio between the total effective average tax rate of the top 1% and the bottom 90% decreases substantially from 2.9 to 2.2 if half of the corporate tax burden is borne by labor, or to 1.9 if the full corporate tax burden is shifted onto wages. We find similar relative changes of progressivity for the German tax system (decreasing from 6.1 to 4.6 and 3.7). Overall, our calculations imply that the progressivity of the overall tax system in both countries would decline by between 25 and 40% if we account for our incidence estimates.

6 Conclusions

In this paper, we exploit the compelling institutional setting of the German local business tax to analyze the incidence of corporate taxes on wages. We combine administrative information from 1993 to 2012 on the universe of municipalities with administrative linked employer-employee data to estimate the causal effect of corporate taxation on wages.

[36] Further details are explained in the notes to Appendix Table D.9.

Averaging over firms liable to the LBT, workers bear about 51% of the total tax burden. This finding is similar to other studies analyzing the corporate tax incidence on wages (Arulampalam, Devereux and Maffini, 2012; Liu and Altshuler, 2013; Suárez Serrato and Zidar, 2016).

Our results thus confirm the view that labor bears a substantial share of the corporate tax burden. Importantly, our results are obtained by exploiting variation at the local level. Corporate taxes levied at the subnational level exist in many countries, and our results are likely to be relevant in these countries as well. At the same time, it is important to discuss how our findings are related to settings with state-level or national corporate taxes. Two differences are important. On the one hand, labor is likely to be more mobile at the local level, which attenuates the incidence on wages. On the other hand, focusing on tax changes at the municipal level implies that changes of prices other than wages, in particular output prices and prices of intermediate goods, are probably much smaller than in the case of national corporate tax changes. This would imply that wage effects of local tax changes are larger.

Going beyond the average wage effect, our analysis shows that incidence estimates differ considerably across firms and individuals. First, we do not find effects for firms that are not liable to the LBT. Second, our findings suggest that labor market institutions play a key role for the incidence of corporate taxes on wages. If there is rent sharing in the labor market, due to collective bargaining, for instance, wage responses are larger. Third, wage effects are close to zero for firms that operate in multiple jurisdictions, large firms and foreign-owned firms. This may be explained by profit-shifting opportunities available to these firms. Clearly, the heterogeneous results are correlations and should be seen as a first step toward understanding the underlying mechanisms of the incidence of corporate taxation on wages. For a more rigorous test of competing theories, additional exogenous variation in labor market institutions and other firm characteristics would be necessary.

The heterogeneous worker analysis reveals stronger wage effects for low-skilled workers, women and young workers. High-skilled employees are not affected at all. This challenges the widespread view that the corporate income tax is highly progressive. In fact, our estimates imply that the shifting of part of the corporate tax burden onto wages reduces the overall progressivity of the tax systems both in Germany and the U.S. by 25 to 40% compared to a hypothetical situation where no shifting occurs.

An important limitation of our analysis is that we focus on wage effects and do not investigate the impact of tax changes on quantities of input factors, on output or on entry and exit of firms. These potential responses are important for the efficiency costs of taxes. Another limitation is that we do not consider the impact on land rents. These are issues for future research.

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Appendices for online publication only

A The theory of corporate tax incidence

The theoretical literature has produced various models of corporate tax incidence. These models lead to different predictions, depending on the assumptions made about factor and output markets, wage-setting institutions, the structure of the tax system and behavioral reactions to tax changes. In the seminal paper by Harberger (1962), the economy is closed, labor markets are competitive and capital is in fixed supply. At least for plausible parameter values, the corporate tax burden is almost fully borne by capital.[37] The subsequent literature has emphasized the importance of international capital mobility in open economies (Diamond and Mirrlees, 1971*a*,*b*; Bradford, 1978; Kotlikoff and Summers, 1987; Harberger, 1995).[38] In these models, the share of the (source-based) corporate tax burden bore by domestic immobile factors increases as the size of the economy relative to the rest of the world decreases. In the case of a small open economy that faces a perfectly elastic supply of capital, the burden of the corporate tax is fully borne by factors other than capital. If profits of a firm are the result of location specific rents, the tax will partly fall on these rents. By contrast, if rents are firm specific and firms are mobile, the tax burden will be fully shifted to owners of immobile factors like land or labor.[39]

However, complete immobility of labor is a strong assumption, in particular when considering corporate taxes at the sub-national level. Another restrictive assumption of standard models is that labor markets are competitive. Relatively little attention has been paid to the role of wage-setting institutions and labor market frictions in the context of corporate taxation, two exceptions the studies by Felix and Hines (2009) and Arulampalam, Devereux and Maffini (2012).

In this Appendix, we discuss the implications of various wage-setting models for the impact of corporate tax changes on wages. As will be explained further below, the model will be varied slightly to incorporate different assumptions about wage setting and two aspects of the tax system relating to formula apportionment and income shifting.

Consider an economy which consists of n jurisdictions. There is a large number of

[37] Feldstein (1974) and Ballentine (1978) study tax incidence in models with endogenous savings and find that part of the tax burden is shifted to labor.

[38] Other important extensions of the canonical Harberger model focus on the sectoral composition (Shoven, 1976), savings behavior (Feldstein, 1974; Bradford, 1978) and the presence of uncertainty in the economy (Ratti and Shome, 1977).

[39] From a global perspective, a tax increase in one jurisdiction reduces the income of immobile factors in that jurisdiction but increases the income of immobile factors and reduces capital income in the rest of the world. In principle, the burden of corporate taxes may also fall on suppliers or on customers, provided input and output prices are not pinned down by international markets.

firms in the economy. To ease notation we normalize the number of firms per jurisdiction to unity. Firms use the following factors of production: capital (K) and labor of two skill levels. Labor of skill type k, $k = h, l$, is denoted by L^k.[40] We will consider different production technologies. In the base version of the model we consider a concave production function $F(K, L^h, L^l)$, which is assumed to exhibit declining returns to scale. One interpretation is that there is an implicit fourth factor, which may be interpreted as a location-specific rent. While capital and both types of labor are mobile across municipal borders, firms are immobile, due to the location-specific rent.

The after-tax profit of firm i located in jurisdiction j , $j = 1...n$, is given by

$$P_{ij} = p_i F_i(K_i, L_i^h, L_i^l)(1 - \tau_j) - \textstyle\sum_k w_i^k L_i^k (1 - \tau_j) - (1 - \alpha\tau_j) r_i K_i \qquad (5)$$

where p_i is the output price, r_i is the non-tax cost of capital and w_i^k is the wage labor of skill type k. In some variants of the model, labor markets may not clear. In these cases, we assume that unemployed workers of skill type k receive unemployment benefits denoted by $\overline{w}^k$. The tax rate on corporate profits in jurisdiction j is denoted by τ_j.

The variable α, with $0 \leq \alpha \leq 1$, is a tax base parameter representing the share of the capital cost which can be deducted from the tax base. This parameter is the same in all jurisdictions. A cash-flow tax would imply $\alpha = 1$, that is full deductibility of all costs. Most existing corporate tax systems are more restrictive, however. Costs of debt financing are usually deductible while costs of equity financing are not and loss offset is typically restricted. These properties of the corporate tax base are important for theoretical predictions about the incidence of the tax, as will be shown below.

In the following we drop the index j for firm variables to ease notation. Total differentiation of the profit equation and using the standard first order conditions for profit-maximization yields

$$dP_i = - d\tau_j T_i + dp_i F_i(K_i, L_i^h, L_i^l)(1 - \tau_j) - \textstyle\sum_k dw_i^k L_i^k (1 - \tau_j) - dr_i (1 - \alpha\tau_j) K_i \qquad (6)$$

where $T_i = p_i F_i(K_i, L_i^h, L_i^l) - \sum_k w_i^k L_i^k - \alpha r_i K_i$ is the profit tax base. Equation (6) shows that a tax increase may lead to lower profits for firm owners, higher output prices charged to customers, a decline in wages received by workers, lower income for capital owners or a combination of these effects. It is also possible that some of these groups lose while others gain.

The distribution of the tax burden depends on how the model is closed, that is,

[40] To keep the notation simple we abstract from other input factors like land, energy or other intermediate goods. Clearly, the prices of these goods could also be affected by corporate tax changes and the suppliers might bear part of the corporate tax burden. Corporate tax changes could also be capitalized in house prices.

on the assumed overall structure of the economy, in particular the supply and demand elasticities in factor markets and the wage-setting institutions. In the following, we discuss the corporate tax incidence on wages under different assumptions about the labor market regime. As a benchmark, we start with the case of competitive labor markets. We then turn to models with wage bargaining, fair wage models, models where wages affect worker productivity and monopsonistic labor markets. In all of the following cases, we assume that output markets are perfectly competitive and normalize the price p of the output good to equal 1.

A.1 Competitive labor markets

Assume that input markets are perfectly competitive, so that factor prices will adjust to equate demand and supply. Factor demand functions are given by the firm's first order conditions

$$\frac{\partial F_i(K_i, L_i^h, L_i^l)}{\partial K_i} = \frac{(1-\alpha\tau_i)}{(1-\tau_i)} r \tag{7}$$

and

$$\frac{\partial F_i(K_i, L_i^h, L_i^l)}{\partial L_i^k} = w_i^k, \qquad k = h, l. \tag{8}$$

Equations (7) and (8) implicitly define the factor demand functions

$$K_i^D(w_i^h, w_i^l, R_i) \quad \text{and} \quad L_i^{kD}(w_i^h, w_i^l, R_i) \quad k = h, l$$

where $R_i = r\frac{1-\alpha\tau_i}{1-\tau_i}$ is the tax inclusive cost of capital. While the interest rate r is assumed to be independent of capital demand in jurisdiction j, wage rates are determined by equating labor demand and labor supply. Labor supply is derived from worker utility maximization. Denote the utility of a worker of skill type k by $U_i^k(C_i^k, L_i^k)$. C_i^k is the worker's consumption and her budget constraint is given by $C_i^k = w_i^k(1-t)L_i^k$ where t is the personal income tax rate. Standard utility maximization leads to a labor supply function which can be expressed as $L_i^{kS}(w^k), k = h, l.$[41]. Standard comparative static analysis of the labor market equilibrium conditions $L_i^{kD}(w_i^h, w_i^l, R_i) = L^{kS}(w^k), k = h, l$ yields expressions for the impact of a tax rate change on the skill-specific wage. Consider

[41] For notational convenience we express the labor supply function as a function of the wage rate before income taxation

for example the effect on wages of skill type h:

$$\frac{dw_i^h}{d\tau_i} = \frac{L_i^{hD} L_i^{lD}}{\varphi} \left(\varepsilon_{lR} \frac{1-\alpha}{(1-\alpha)(1-\alpha\tau_i)} \right) \left(\varepsilon_{hh} \frac{1}{w_i^h} \right) - \frac{L_i^{hD} L_i^{lD}}{\varphi} \left(\varepsilon_{hR} \frac{1-\alpha}{(1-\alpha)(1-\alpha\tau_i)} \right) \left((\varepsilon_{ll} - \mu_l) \frac{1}{w_i^h} \right) \quad (9)$$

where φ is a positive parameter (the determinant of the matrix of coefficients). Parameter ε_{st} is the labor demand elasticity of skill group s with respect to wage changes of skill type t and is defined as $\varepsilon_{st} = \frac{\partial L_i^{sD}(w_i^h, w_i^l, R_i)}{\partial w_i^t} \frac{w_i^t}{L_i^{sD}(w_i^h, w_i^l, R_i)}$, $s, t = h, l$. The labor supply elasticity of skill type k is given by $\mu_k = \frac{\partial L_i^{kS}(w^k)}{\partial w^k} \frac{w^k}{L_i^{kS}(w^k)}$, $k = h, l$.

Equation (9) shows that, in general, the impact of a tax change on the wage depends on demand and supply elasticities in the labor market. However, if the corporate tax is a cash-flow tax ($\alpha = 1$), a change in the corporate tax rate will be neutral for factor demand and, hence, will leave wages unchanged. As a result, the corporate tax is a lump sum tax and the tax burden falls entirely on profits:

$$\frac{\partial P_i}{\partial \tau_i} = -[p_i F_i(K_i, L_i^1, L_i^2) - \sum_{k=1}^{2} w_i^k L_i^k - \alpha r K_i] < 0, \frac{\partial w_i^k}{\partial \tau_i} = 0 \quad k = 1, 2.$$

This may be stated as

Result 1: *Competitive labor markets*: The impact of a tax change on wages depends on the demand and supply elasticities in the labor market. If all costs are perfectly deductible, the burden of the corporate income tax is fully borne by firm owners. Then a tax rate change does not affect the wage rate.

Interestingly, the cash-flow tax result also carries over to various (but not all) standard models of *imperfect* labor markets, as we will show below. Most real world corporate tax systems deviate from the polar case of a profit tax with perfect cost deductibility, though. Accordingly, models of tax incidence in the literature typically consider settings where either capital or labor costs are less than fully deductible.

A.2 Wage bargaining

Various labor market theories assume that wages are set via bargaining between firms and their employees. Bargaining models imply that firm owners and employees share a surplus generated by the firm. If corporate taxes reduce this surplus, it is straightforward to expect that employees share part of the loss through lower wages. The magnitude of these wage effects depends on the level where bargaining takes place. We consider individual and collective (firm and sector-level) bargaining.

A.2.1 Individual wage bargaining

Assume that the wage is set via bargaining between the firm and the employee. The most widely used labor market model where this happens is the job search model, where firms and individual employees bargain over a matching rent (see Rogerson, Shimer and Wright, 2005, for a survey).

Let the output a worker of type k in firm i be given by $Q_i^k(K_i^k)$. The additional profit the firm earns is $P_i^{IB} = Q_i^k(K_i^k)(1-\tau_i) - w_i^k(1-\tau_i) - (1-\alpha\tau_i)rK_i^k$. The variable K_i^k is the capital the firm invests to equip the worker. The outcome of the bargaining process is given by

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

where

$$\Omega_i = \beta_i^k \ln(w_i^k - \overline{w}^k) + (1-\beta_i^k) \ln P_i^{IB}.$$

The variable $\beta_i^k \in (0,1)$ stands for the relative bargaining power of the employee. The first order conditions of the bargaining problem yield

$$w_i^{k*} = (1-\beta_i^k)\overline{w}^k + \beta_i^k \frac{Q_i^k(K_i^k)(1-\tau_i) - (1-\alpha\tau_i)rK_i^k}{(1-\tau_i)}. \tag{10}$$

The effect of a change in the corporate tax rate on the wage is

$$\frac{\partial w_i^{k*}}{\partial \tau_i} = -\beta_i^k \frac{(1-\alpha)rK_i^k}{(1-\tau_i)^2} \leq 0. \tag{11}$$

A higher corporate tax reduces the wage unless capital costs are fully deductible. Since the employee's share of the surplus generated by the firm is increasing in the employee's bargaining power, it is plausible that she also bears a larger loss if her bargaining power is higher. This may be stated as

Result 2: *Individual wage bargaining*: If capital costs are less than fully deductible, an increase in the local corporate tax rate reduces the wage.

This wage change increases with the bargaining power of the employee. If the employee receives a large part of the surplus generated by the firm, she also bears a large loss if the surplus declines due to taxation.

A.2.2 Collective bargaining

Assume that trade union represent workers. We consider two cases: The first case is firm-level bargaining, where firm-level unions bargain with individual firms. The second case is sector-level bargaining, where sector-level unions bargain with sector-level employer organizations.

Firm-level bargaining. Denote the wage for a worker of skill type k employed by a firm located in jurisdiction i by $w_i^k = \overline{w}_i^k + s_i^k$, where s_i^k is the wage premium generated by bargaining at the firm-level. The bargaining model we use for the firm-level is a standard efficient bargaining model (McDonald and Solow, 1981), where unions and firms bargain over the wage premium, s_i^k, and employment L_i^k. Each skill type is represented by one trade union and each firm negotiates with the two unions simultaneously (Barth and Zweimüller, 1995). The objective function of the trade union representing the workers of skill type k in firm i is given by

$$Z_i^k = L_i^k(w_i^k - \overline{w}^k) = L_i^k s_i^k.$$

In case of disagreement, the rent of the union Z_i^k and the firm's profit P_i^{FB} are equal to zero. After wages and employment levels are determined, firms set K_i to maximize profits:

$$\frac{\partial F(K_i, L_i^h, L_i^l)}{\partial K_i} = R_i \tag{12}$$

where R_i denotes the cost of capital:

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

The outcome of the bargaining process is given by

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

where

$$\Omega_i^k = \beta_i^k \ln Z_i^k + (1-\beta_i^k) \ln P_i^{FB}.$$

The variable $\beta_i^k \in (0,1)$ stands for relative bargaining power of the skill type k union in firm i. The first order conditions of the bargaining problem yield

$$s_i^{k*} = \frac{(1-\beta_i^j)\beta_i^k}{(1-\beta_i^k\beta_i^j)} \frac{\Pi_i^{FB}}{L_i^k(1-\tau_i)} \quad k,j = h,l, \quad k \neq j \tag{13}$$

where

$$\Pi_i^{FB} = F(K_i, L_i^h, L_i^l)(1-\tau_i) - \textstyle\sum_k \overline{w}^k L_i^k(1-\tau_i) - (1-\alpha\tau_i)rK_i.$$

For employment we find

$$\frac{\partial F(K_i, L_i^h, L_i^l)}{\partial L_i^k} = \overline{w}^k \quad k = h,l. \tag{14}$$

The wage premium s_i^{k*} is equal to a share of the surplus per employee generated by the firm. The size of this share is increasing in the relative bargaining power of the skill group and decreasing in the bargaining power of the other group of employees. Employment is set so that the marginal productivity of labor is equal to the skill-specific reservation wage. Differentiating (13) yields

$$\frac{ds_i^{k*}}{d\tau_i} L_i^k + s_i^{k*} \frac{dL_i^k}{d\tau_i} = -\beta_0 \left((1-\alpha)rK_i\right) \leq 0 \tag{15}$$

where

$$\beta_0 = \frac{(1-\beta_i^j)\beta_i^k}{(1-\beta_i^k\beta_i^j)(1-\tau_i)^2} > 0.$$

The left-hand side of (15) is equal to the change in the rent accruing to the workers of skill type k employed by firm i. This rent unambiguously declines because of the tax change. Whether the wage rate declines depends on how employment changes in response to the tax change. Equations (12) and (14) implicitly define the factor demand functions $K_i(\overline{w}^k, \overline{w}^j, \tau_i, ..), L_i^k(\overline{w}^k, \overline{w}^j, \tau_i, ..)$. Standard comparative static analysis shows that the impact of a tax change on demand for labor of type k may be positive or negative, depending on whether the different production factors are complements or substitutes. The effect on wages is therefore also ambiguous.

This may be summarized as:

Result 3: *Firm-level bargaining*: If capital costs are less than fully deductible, an increase in the local corporate tax rate reduces the rent of each skill group. The effect on the wage rate is ambiguous and depends on potential changes in employment.

This result is similar to that of individual bargaining. Higher taxes reduce the rent that can be shared between the firm and its employees. For given levels of employment, wages unambiguously decline in response to a tax increase. In the literature, this effect has been referred to as the "direct effect" of a corporate tax change on wages in firms where wages are set via collective bargaining (Arulampalam, Devereux and Maffini, 2012; Fuest, Peichl and Siegloch, 2013). Taking into account changes in employment may change the wage effect ("indirect effect"). If the number of employees declines in response to a tax increase, the rent generated by the company is shared among a smaller number of employees and the overall wage effect can be positive or negative.

Sector-level bargaining. We now assume that bargaining takes place at the sector-level. To ease notation we normalize the number of sectors in the unionized part of the labor market to unity. This implies that there are n firms in the sector. An employer organization bargains with sector-level unions over the sector wide wage. We continue to assume that each skill group is represented by its own trade union. The employer organization has the objective of maximizing aggregate profits of the firms in the sector. Following the seniority model proposed by Oswald (1993), we assume that each union wishes to maximize the premium over the reservation wage for the skill group it represents, which is given by $v^k = w^k - \overline{w}^k$. For given wages, firms set profit-maximizing employment. The outcome of the sector-level bargaining process is given by

$$v^{k*} = \arg\max_{v^k} \Omega_i^{Sk}$$

where

$$\Omega_i^{Sk} = \gamma^k \ln v^k + (1 - \gamma^k) \ln \sum_{i=1}^{m} P_i^{SB}.$$

The variable $\gamma^k \in (0, 1)$ stands for the relative bargaining power of the sector-level skill type k union. Rearranging the first order condition of the bargaining problem yields

$$v^{k*} = \gamma_0 \frac{\sum_{i=1}^{n} \Pi_i^{SB}}{\sum_{i=1}^{n} L_i^k (1 - \tau_i)} \quad k, j = h, l, \quad k \neq j \tag{16}$$

where

$$\gamma_0 = \frac{(1 - \gamma^j)\gamma^k}{(1 - \gamma^j \gamma^k)} > 0.$$

The sector wide wage premium is equal to a share of the average surplus per worker generated by the firms in the sector. Employment and investment decisions are now given by

$$\frac{\partial F(K_i, L_i^h, L_i^l)}{\partial L_i^k} = w^k \quad k = h, l \tag{17}$$

and

$$\frac{\partial F(K_i, L_i^h, L_i^l)}{\partial K_i} = R_i.$$

We now analyze the effect of a corporate tax change in jurisdiction m , $m \in (1, ..., n)$, on v^{k*}. Total differentiation of equation (16) yields

$$dv^{k*} = \gamma_0 \frac{\left[L_m^k d\tau_m - \sum_{i=1}^{n} dL_i^k (1-\tau_i)\right] \sum_{i=1}^{n} \Pi_i^{SB} + \sum_{i=1}^{n} d\Pi_i^{FB} \sum_{i=1}^{n} L_i^k (1-\tau_i)}{\left[\sum_{i=1}^{n} L_i^k (1-\tau_i)\right]^2} \quad k, j = h, l, \quad k \neq j \tag{18}$$

where

$$\sum_{i=1}^{n} d\Pi_i^{FB} = -\left[F(K_m, L_m^h, L_m^l) - \sum_k \overline{w}^k L_i^k - \alpha r K_i\right] d\tau_m + \left(v^{h*} \sum_{i=1}^{n} dL_i^h (1-\tau_i) + v^{l*} \sum_{i=1}^{n} dL_i^l (1-\tau_i)\right).$$

In general, the impact of a tax change on the wage is ambiguous.

The wage effect converges to zero if the firm in the jurisdiction where the tax change occurs is small, relative to the sector as a whole. The conditions for the wage effect to be negligible $dv^{k*} \to 0$, which implies $dL_i^k = 0$ for all $i \neq m, k = h, l$ follow from (18) and are given by

$$\frac{\left[L_m^k - \frac{\partial L_m^k}{\partial \tau_m (1-\tau_m)}\right]}{\sum_{i=1}^{n} L_i^k (1-\tau_i)} \to 0, \frac{F(K_m, L_m^h, L_m^l) - \sum_k w^k L_m^k - \alpha r K_m}{\sum_{i=1}^{n} L_i^k (1-\tau_i)} \to 0. \tag{19}$$

The effect is thus negligible if employment (including the tax induced change in employment) as well as the tax base in jurisdiction m are small, relative to the number of employees in the sector as a whole, weighted with the tax factors $(1 - \tau_i)$.

This may be summarized as

Result 4: *Sector-level bargaining*: If capital costs are less than fully deductible, an increase in the tax rate may increase or decrease wages. The wage effect converges to zero if the activity of the sector in the jurisdiction where the tax change occurs is small, relative to the rest of the sector.

Result 4 suggests that local tax changes will have a smaller or negligible effect on wages if wage bargaining takes place at the sector level, rather than the firm level, because the sector will usually include many jurisdictions.[42]

A.3 Fair wage models

In fair wage models (Akerlof, 1982) the wage is usually assumed to be a function of i) wages of other employees of the same firm, ii) an external reference wage[43] and iii) profits of the firm (Amiti and Davis, 2010; Egger and Kreickemeier, 2012).

Consider a firm i with two types of workers. Assume that the fair wage for type k workers employed by firm i is given by the function $w_i^{kf} = f_i^k(\overline{w}_i^k, w_i^{-k}, P_i)$, where $\overline{w}_i^k$ are unemployment benefits, w_i^{-k} are wages of the other skill group in the firm and profits P_i^{FW} are given by

$$P_i^{FW} = F_i(K_i, L_i^h, L_i^l)(1-\tau_i) - \textstyle\sum_k w_i^k L_i^k(1-\tau_i) - (1-\alpha\tau_i)rK_i.$$

We assume that the fair wage function has the following standard properties:

$$\frac{\partial f_i^k}{\partial \overline{w}_i^k}, \frac{\partial f_i^k}{\partial w_i^{-k}}, \frac{\partial f_i^k}{\partial P_i} > 0, \tag{20}$$

$$\frac{\partial f_i^k}{\partial w_i^{-k}} - \frac{\partial f_i^k}{\partial P_i} L_{-k}(1-\tau_i) > 0, \tag{21}$$

$$1 - \frac{\partial f_i^k}{\partial w_i^{-k}} \frac{\partial f_i^{-k}}{\partial w_i^k} > 0. \tag{22}$$

The fair wage is increasing in unemployment benefits $\overline{w}_i^k$, in the wage of the other skill group employed by the firm and in the firm's profits. Equation (21) implies that the fair wage for skill group k increases if the wage of the other skill group $-k$ increases. This does not follow directly from the first derivatives, as an increase in the wage of the other skill group reduces profits. The effect on profits reduces the fair wage. Equation (22) implies that an increase in any of the reservation wages raises the fair wages of both groups.

[42] Some labor markets are characterized by two tier bargaining, where sector-level bargaining sets a minimum wage and wage premiums on top of the minimum wage are negotiated at the firm-level (Boeri, 2014). In such a setting, one would expect local tax changes to have a more significant impact on local wages than in the case of pure sector-level wage bargaining.

[43] We assume that the reference wage, which can be the average wage level paid in other firms, a statutory minimum wage or a transfer to the unemployed, is given. It may of course be the case that the reference wage is affected by local tax changes. This would not alter the result that higher taxes lead to lower wages and vice versa.

In equilibrium, the firm pays fair wages to both types of employees and sets factor inputs to maximize after-tax profits. Optimal factor inputs are given by the standard marginal productivity conditions. Equilibrium wages are given by

$$w_i^{k*} = f_i^k(\overline{w}_i^k, w_i^{-k*}, P_i^*) \quad k = h, l. \tag{23}$$

Equation (23) implicitly defines the equilibrium wage rates w_i^{h*} and w_i^{l*} as functions of, among other things, the corporate tax rate τ_i. Standard comparative static analysis shows that the effect of a change in τ_i on wages is given by

$$\frac{\partial w_i^{kf*}}{\partial \tau_i} = -\frac{T_i}{\xi}\left[1 + \frac{\partial f_i^{-k}}{\partial P_i} L_k(1-\tau_i) + \frac{\partial f_i^k}{\partial w_i^{-k}} - \frac{\partial f_i^k}{\partial P_i} L_{-k}(1-\tau_i)\right] < 0$$

where

$$T_i = F_i(K_i, L_i^h, L_i^l) - \textstyle\sum_k w_i^k L_i^k - \alpha r K_i$$

is the profit tax base and

$$\begin{aligned}\xi = 1 &- \frac{\partial f_i^k}{\partial w_i^{-k}} \frac{\partial f_i^{-k}}{\partial w_i^k} \\ &+ \left(\frac{\partial f_i^k}{\partial P_i}(L_i^k + \frac{\partial f_i^{-k}}{\partial w_i^k} L_i^{-k}) + \frac{\partial f_i^{-k}}{\partial P_i}(L_i^{-k} + \frac{\partial f_i^k}{\partial w_i^{-k}} L_i^k)\right)(1-\tau_i) > 0.\end{aligned}$$

This may be summarized as

Result 5: *Fair wage model*: An increase in the local corporate tax rate reduces the wages of all skill groups.

The intuition behind Result 5 is that if higher corporate taxes reduce after-tax profits, fairness considerations would suggest that employees will bear part of this burden and vice versa. This effect is independent of whether or not wage and capital costs are fully deductible from the tax base. The neutrality property of cash-flow taxes does not hold here because wage fairness is assumed to depend directly on after-tax profits.

A.4 Models where wages affect labor productivity

Some labor market models emphasize that firms may want to raise wages because higher wages lead to higher labor productivity and, hence, higher output. These models include efficiency wage models, where higher wages lead to more effort or lower worker fluctuation, and models of directed job search, where higher wages lead to better matches between workers and firms.[44]

Following Acemoglu and Shimer (1999), we assume that output is uncertain and depends on the quality of firm worker matches.[45] There is only one type of labor. If a firm offers a higher wage, more workers will apply for the job and the chances of a good match increase, given the wages offered by other firms. With probability $\rho_i(w_i, \mathbf{q})$ the additional output produced by filling a vacancy i in a firm located in jurisdiction j equals $Q_i(K_i)$, with probability $1-$ $\rho_i(w_i, \mathbf{q})$ it is equal to zero. The wages paid by other firms as well as other factors which may be relevant for the likelihood of success are summarized by the vector $\mathbf{q}$. The function $\rho_i(w_i, \mathbf{q})$ has the following properties:[46]

$$\frac{\partial \rho_i}{\partial w_i} > 0, \frac{\partial_i^2 \rho}{\partial {w_i}^2} < 0, \frac{\partial_i^2 \rho}{\partial w_i^k \partial \mathbf{q}} = 0. \tag{24}$$

Expected profits are now given by

$$P_i^e = \rho_i(w_i, \mathbf{q}) Q_i(K_i)(1-\tau_j) - w_i(1-\tau_j) - (1-\alpha\tau_j) r K_i. \tag{25}$$

The first order conditions for the optimal wage and optimal investment are given by

$$\frac{\partial \rho_i}{\partial w_i} Q_i(K_i)(1-\tau_j) - (1-\tau_j) = 0 \tag{26}$$

and

$$\rho_i(w_i, \mathbf{q}) Q_i'(K_i)(1-\tau_j) - (1-\alpha\tau_j) r = 0. \tag{27}$$

Equations (26) and (27) imply that we can write the equilibrium wage rate as a function $w_i^* = w_i^*(\tau_i, \phi, \alpha, r)$. Standard comparative static analysis leads to

$$\frac{\partial w_i^*}{\partial \tau_j} = \frac{-r}{\Delta(1-\tau_j)^2} \left[\frac{\partial \rho_i}{\partial w_i} Q_i'(K_i)(1-\alpha) \right] \leq 0 \tag{28}$$

[44] The key difference to the fair wage model discussed in the preceding section is that the latter emphasizes the *direct* link between the profits of a firm and the wage that is perceived to be fair. No such direct link exists here. However, fair wage models may also be considered as models where wages affect labor productivity because wages deemed as unfair would reduce worker effort or increase costly fluctuation.

[45] The results would be similar in an efficiency wage model following Solow (1979) with continuous effort. In shirking models with discrete effort (such as Shapiro and Stiglitz, 1984), we would not expect a direct effect on wages (for given employment) but only an indirect effect through changes in unemployment rates and hence the shirking constraint.

[46] The assumption that all cross derivatives are equal to zero is made to simplify the exposition, it is not necessary for the results.

where

$$\Delta = \rho_i(w_i, \mathbf{q}) Q_i''(K_i) \frac{\partial^2 \rho_i}{\partial {w_i}^2} Q_i(K_i) - \left[\frac{\partial \rho_i}{\partial w_i} Q_i'(K_i) \right]^2 > 0.$$

Note that $\Delta > 0$ follows from the second order conditions for profit maximization. A higher corporate tax rate thus reduces the wage if there is limited deductibility of capital costs. This may be summarized as

Result 6: *Models where wages affect productivity*: If capital costs are less than fully deductible, an increase in the local corporate tax rate reduces wages.

The optimal wage trades off higher output against the cost of higher wages. The increase in output achieved through a wage increase is higher, the higher the capital stock of the firm. In the presence of imperfect deductibility of capital costs, investment declines when the tax rate increases. Therefore the firm's marginal productivity gain from a wage increase falls. As a result, it is optimal for the firm to adjust its wage policy towards lower wages and a lower quality of worker firm matches.

A.5 Monopsonistic labor market

Consider a firm facing the labor supply function by $L^s = L^s(w)$, $L^{s\prime}(w) > 0$. Output is produced using a standard, strictly concave production technology $F(K_i, L_i)$ with complementarity between labor and capital: $\frac{\partial^2 F(K_i, L^s(w_i))}{\partial K_i \partial L_i} > 0$. Profits are given by

$$P_i^M(K_i, w_i) = F(K_i, L^s(w_i))(1 - \tau_j) - w_i L^s(w_i)(1 - \tau_j) - (1 - \alpha\tau_i) r K_i$$

The first order conditions for profit maximization are

$$\frac{\partial F(K_i, L^s(w_i))}{\partial L_i} L^{s\prime}(w_i)(1 - \tau_j) - (L^{s\prime}(w_i) w_i + L^s(w_i))(1 - \tau_j) = 0 \qquad (29)$$

$$\frac{\partial F(K_i, L^s(w_i))}{\partial K_i}(1 - \tau_j) - (1 - \alpha\tau_j) r = 0 \qquad (30)$$

Equations (29) and (30) implicitly define the profit-maximizing wage rate w_i^* and the capital stock set by the monopsonist, as functions of the tax corporate rate. Standard comparative static analysis leads to

$$\frac{\partial w_i^*}{\partial \tau_j} = -\frac{1}{\Gamma} \left[\frac{\partial^2 F(K_i, L^s(w_i))}{\partial K_i \partial L_i} L^{s\prime}(w_i)(1 - \alpha) \right] < 0.$$

where the second order conditions imply

$$\Gamma = \frac{\partial^2 P_i^M(K_i, w_i)}{\partial K_i^2} \frac{\partial^2 P_i^M(K_i, w_i)}{\partial w_i^2} - \left[\frac{\partial^2 P_i^M(K_i, w_i)}{\partial K_i \partial w_i} \right]^2 > 0.$$

This implies

Result 7: *Monopsonistic labor market*: If capital costs are less than fully deductible, an increase in the local corporate tax rate reduces wages.

A higher corporate tax rate reduces investment so that the marginal productivity of labor falls. As a result, firms employ less labor. In a monopsonistic labor market this implies a lower wage.[47]

A.6 Extensions

In this subsection, we consider two extensions of the model that are both related to particular aspects of corporate taxation. The first extension takes into account that firms may operate in more than one jurisdiction. Many countries use formula apportionment to allocate corporate profits to different jurisdictions for taxation purposes. The second extension is to allow for tax avoidance through different types of income shifting.

A.6.1 Firms operating in multiple jurisdictions with formula apportionment

Consider a company with plants in two jurisdictions, 1 and 2. As a first step, we assume that there is just one type of labor.[48] Employment (capital) in jurisdiction j is denoted by L_j $(K_j), j = 1, 2$. The wage rate is the same in both plants. After-tax profits of the company are

$$P_i^{FA} = F(K_1, K_{2,}L_1, L_2)(1 - \tau_i) - (1 - \tau_i)w[L_1 + L_2] - (1 - \alpha\tau_i)r[K_1 + K_2]$$

Assume that the tax apportionment formula is based on payroll as the only apportionment factor.[49] Given that there is a uniform wage rate in the two plants, the profit tax rate is given by

$$\tau_i = \frac{\tau_1 L_1 + \tau_2 L_2}{L_1 + L_2}. \tag{31}$$

The effect of a tax rate change in one jurisdiction on the firm's effective profit tax rate τ, given the level of employment, is

$$\frac{\partial \tau_i}{\partial \tau_j} = \frac{L_j}{L_1 + L_2}, \quad j = 1, 2$$

[47] This result holds in models of monopsonistic wage setting with constant labor supply elasticities. If this assumption is relaxed, the result on tax shifting is theoretically ambiguous.

[48] The case for two skill types is discussed below.

[49] This is the case for the LBT in Germany. In the US, apportionment for state taxes is based on payroll, sales, and assets, see Suárez Serrato and Zidar (2016).

where τ_j is the tax rate of jurisdiction j.

Assume that wages are set via collective bargaining which 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 objective function of the skill type k union is now given by

$$Z^{FA} = (L_1 + L_2)(w - \overline{w}) = (L_1 + L_2)s^{FA}.$$

The outcome of the bargaining process is given by

$$s^{FA*}, L_1^*, L_2^* = \arg \max_{s^{FA}, L_1, L_2} \Omega^{FA}$$

where

$$\Omega^{FA} = \lambda \ln Z_i^{FA} + (1 - \lambda) \ln P_i^{FA}.$$

The variable $\lambda \in (0, 1)$ stands for the relative bargaining power of the union. The first order condition for the wage rate yields

$$s^{FA*} = \lambda \frac{\Pi_i^{FA}}{[(L_1 + L_2)(1 - \tau_i)]}$$

where

$$\Pi_i^{FA} = F(K_1, K_{2,} L_1, L_2)(1 - \tau_i) - (1 - \tau_i)\overline{w}[L_1 + L_2] - (1 - \alpha\tau_i)r[K_1 + K_2].$$

For given levels of employment, the change in the wage premium caused by a change in the tax rate is given by

$$\frac{\partial s^{FA*}}{\partial \tau_j} = -\lambda \frac{(1 - \alpha)r(K_1 + K_2)L_j}{(L_1 + L_2)^2(1 - \tau_j)^2} \leq 0.$$

This implies:

Result 8: *Formula apportionment and firm-level bargaining*: In firms with plants in many jurisdictions and homogeneous labor, where corporate taxation is based on formula apportionment, wages are set via collective bargaining at the firm-level, and capital costs are less than fully deductible, an increase in the corporate tax rate in one jurisdiction decreases wages in the entire firm. If employment in the jurisdiction that changes the tax rate is small, relative to employment in the firm as a whole, the tax effect is also small.

Consider next the case of two skill types, $k = h, l$. After-tax profits of the company are now

$$P_i^{FA_k} = F(K_1, K_{2,}L_1^h, L_1^l, L_2^h, L_2^l)(1-\tau_i) - \left(\sum_j \sum_k w^k L_j^k\right)(1-\tau_i) - (1-\alpha\tau_i)r[K_1 + K_2]$$

with obvious notation. The profit tax rate is given by

$$\tau_i = \frac{\sum_j \sum_k \tau_j w^k L_j^k}{\sum_j \sum_k w^k L_j^k}.$$

For given employment, the effect of a tax rate change in one jurisdiction on the firm's effective profit tax rate τ_i is

$$\frac{\partial \tau_i}{\partial \tau_j} = \frac{\sum_k w^k L_j^k}{\sum_j \sum_k w^k L_j^k}.$$

The effect of a wage change for workers of skill type h on the effective profit tax rate is:

$$\frac{\partial \tau_i}{\partial w^h} = [\tau_1 - \tau_2]\left[\frac{L_1^h}{L_1^l} - \frac{L_2^h}{L_2^l}\right] L_1^l L_2^l \frac{1}{\sigma}$$

where

$$\sigma = \left[1 + \frac{w^h L_1^h + w^l L_1^l}{w^h L_2^h + w^l L_2^l}\right]^2 [w^h L_2^h + w^l L_2^l]^2 > 0.$$

Assume, for instance, that municipality 1 has a higher tax rate than municipality 2. The effect of an increase in the wage of the high skilled w^h on the tax burden will depend on whether this increases the payroll share of the high tax municipality, or that of the low tax municipality. If the share of high skilled is higher in jurisdiction 1, so that $\left[\frac{L_1^h}{L_1^l} - \frac{L_2^h}{L_2^l}\right] > 0$, the tax rate τ_i will increase, and vice versa. The effect of a wage change on the profit tax rate a firm effectively pays is therefore generally ambiguous.

Once again assuming firm-level collective bargaining and homogeneous wages for a skill group across plants, the objective function of the skill type k union is now given by

$$Z^{FAk} = (L_1^k + L_2^k)(w_1^k - \overline{w}^k) = (L_1^k + L_2^k)s^{FA^k}.$$

The outcome of the bargaining process is given by

$$s^{FA^{k*}}, L_1^{k*}, L_2^{k*} = \arg \max_{s^k, L_1^k, L_2^k} \Omega^{FAk}$$

where

$$\Omega^{FAk} = \lambda^k \ln Z_i^{FAk} + (1-\lambda^k) \ln P_i^{FAt}.$$

As above, the variable $\lambda^k \in (0,1)$ stands for relative bargaining power of the skill type k union. The first order condition for the wage rate yields

$$s^{FA^{k*}} = \frac{\lambda^k}{(1-\lambda^k)} \frac{P^{FAt}}{[(L_1^k + L_2^k)(1-\tau_i) - \Phi_w^k]}, \qquad k = h, l \tag{32}$$

where

$$\Phi_w^k = \frac{\partial P_i^{FA}}{\partial \tau_i} \frac{\partial \tau_i}{\partial w^k}.$$

The key difference between this case and that with homogeneous labor is that a wage change now affects the effective tax rate. It thus influences the outcome of union-firm bargaining. For instance, if a higher wage increases the effective tax rate, which implies $\Phi_{wk} < 0$, the wage premium achieved by the union will be smaller, other things equal, and vice versa. Equation (32) implicitly defines the two firm-specific wage premiums emerging from the bargaining process as functions of the type $s^{FAk*} = s^{FAk*}(\tau_i, \tau_j, T, L_i^{k*}, L_j^{k*}...)$. Differentiating (32) shows that the change in the local corporate tax rate on wages is, in general, ambiguous.

A.6.2 Income shifting

Income shifting to avoid taxes may occur in different forms. Multinational firms can use debt financing or transfer pricing to shift profits across national borders. Income shifting may also occur between different tax bases within a country. For instance, firm owners may shift income between the corporate and the personal income tax base by changing wages paid to family members. We discuss the two cases in turn.

International income shifting. Assume that the firm's profits are given by

$$P_{ij}^S = p_i F_i(K_i, L_i^h, L_i^l)(1-\tau_j) - \textstyle\sum_k w_i^k L_i^k (1-\tau_j) - (1-\alpha_j \tau_j) r_i K_i + \theta_{ij} S_i - c(S_i). \tag{33}$$

The variable S_i is income shifted from the profit tax base to the personal income tax base of the firm owners, which may be positive or negative, θ_{ij} is the tax benefit per unit of income shifted and $c(S_i)$ is a convex shifting cost function.[50] Profit maximization factor

[50] Here we assume that profit shifting is carried out by changing the wages of firm owners working in the firm or family members of the firm owner. This implies that s_i would be reported as wage income. Another way of shifting income is to provide capital in the form of debt, rather than equity. Many countries have introduced anti-tax-avoidance legislation, which limits income shifting. We therefore take

input decisions lead to the usual marginal productivity conditions, and optimal income shifting implies $c'(S_i) = \theta_{ij}$ so that the profit-maximizing amount of shifted income S_i^* can be expressed as a function of the tax benefit $S_i^* = S_i^*(\theta_{ij})$, with $S_i^{*\prime} > 0$. Consider first the case of a multinational company which is able to shift income abroad. If the firm can do so, for instance, through a foreign subsidiary charging a fully deductible cost to the domestic parent company, the tax advantage from income shifting is given by $\theta_{ij} = \tau_j - \tau_f$, where τ_f is the foreign profit tax rate. Assume that wages in the multinational firm are determined by firm-level bargaining. In this case, the wage premium generated by union firm bargaining is given by

$$z_i^{k*} = \frac{(1-\beta_i^j)\beta_i^k}{(1-\beta_i^k\beta_i^j)} \frac{\Pi_i^S}{L_i^k(1-\tau_i)} \qquad k, j = h, l, \quad k \neq j \tag{34}$$

where

$$\Pi_i^S = F(K_i, L_i^h, L_i^l)(1-\tau_i) - \textstyle\sum_k \overline{w}^k L_i^k(1-\tau_i) - (1-\alpha\tau_i)rK_i + (\tau_j - \tau_f)S_i - c(S_i).$$

Differentiating (34) yields

$$\frac{dz_i^{k*}}{d\tau_i} L_i^k + z_i^{k*} \frac{dL_i^k}{d\tau_i} = -\beta_0^S[(1-\alpha)rK_i - (S_i(1-\tau_f) - c(S_i))] \leq 0 \tag{35}$$

where

$$\beta_0^S = \frac{(1-\beta_i^j)\beta_i^k}{(1-\beta_i^k\beta_i^j)(1-\tau_i)^2} > 0 \qquad k, j = h, l, \quad k \neq j.$$

The right-hand side of (35) is increasing in S_i (given that $S_i = S_i^*$), which implies that the decline in the rent accruing to labor is smaller, the higher the equilibrium level of income shifting. This yields

Result 9 *International income shifting*: If firms engage in international income shifting and wages are set by firm-level bargaining, the decline in the rent accruing to labor caused by a higher corporate tax decreases as the equilibrium level of income shifting increases.

National income shifting. We now consider the possibility of domestic income shifting between the profit tax base and wage income. In this case the tax advantage from income shifting is given by $\theta_{ij} = \phi_j\tau_j - t_{pi}$, where t_{pi} is the marginal tax rate on wage income of

into account costs of income shifting. This can be interpreted as the cost of hiring tax consultants or the cost of concealing income shifting. For notational simplicity we assume that shifting costs are not tax deductible.

the relevant employee. This is relevant in settings where the wages of some employees are effectively profit distributions, so that wage bargaining plays no role for them. Assume that the wages paid in the absence of incentives for income shifting, that is for equal taxes on profits and labor income, would be given by the function $w_i^{kS}(\tau_j, ...)$. Then the *observed* change in the wages paid out by the firm would equal $\sum_k \frac{dw_i^{kS}}{d\tau_j} L_i^k + \frac{dS_i}{d\tau_j}$. While 'true' wages are likely to decline in response to higher taxes, albeit by less than they would in the absence of income-shifting possibilities, we now have the additional effect that the income-shifting effect $\frac{dS_i}{d\tau_j} > 0$ increases reported wages. Thus if income shifting is important, we would expect observed wages to decline less, or even increase, in response to higher corporate taxes. This may be summarized as

Result 10 *National income shifting*: If firms shift income between the profit tax base and the labor income tax base, a higher corporate tax rate will lead to a smaller decline in reported wages than in the absence of income shifting. Wages may even increase.

Unfortunately, we cannot test this mechanism directly with our data because we do not know whether there are employees who are members of the owner family.

B Institutional background

B.1 German business taxes

In 2007, profit taxes accounted for about 6.2% of total tax revenue (including social security) in Germany (OECD, 2015).[51] In terms of tax revenues, the LBT is the most important profit tax, accounting for about 60–70% of total profit tax revenues from corporate firms. Overall, the share of profit tax revenues from local taxes is relatively high in Germany compared with other countries. In the US, for instance, state and local corporate taxes together account only for about 20% of total corporate taxes (NCSL, 2009). In addition, the LBT is the most important source of financing at the disposal of municipalities, generating roughly three quarters of municipal tax revenue.

As mentioned in Section 2, there are two other profit taxes in Germany, the corporate income tax (CIT), which applies to corporations, and the personal income tax (PIT), which applies to non-corporate firms. We discuss the most important features of these two taxes in turn.

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

There are two steps to calculating the total statutory tax rate for corporate firms. First, LBT and CT rates are added. Second, the deduction of the LBT payments from the tax base has to be taken into account. The statutory tax rate for corporate firms, τ^{corp}, from 1998 to 2007, is $\tau^{corp} = \frac{\tau_{CIT} \cdot (1+soli) + t^{fed}_{LBT} \cdot \theta^{mun}_{LBT}}{1+t^{fed}_{LBT} \cdot \theta^{mun}_{LBT}}$. Since 2008, the denominator of the equation is equal to 1, as the LBT can no longer be deducted from the tax base.

Personal income tax. Non-corporate firms (*Personengesellschaften*) are subject to the progressive personal income tax (on operating profits assigned to the proprietor). Non-corporate firms have an LBT allowance of 24,500 euros and a reduced t^{fed}_{LBT} for small non-corporate firms prior to 2008: for every 12,000 euros exceeding the allowance of

[51] This is below the OECD average of about 10.6% (US: 10.8%, UK: 9.4%). Part of this relatively low share of profit taxes is due to the rather high share of social insurance contributions (SIC) in Germany. If SIC are excluded, the share in total taxes is about 11.5%. A high share of unincorporated firms in Germany is a second factor. These firms pay PIT, in addition to the LBT, and the OECD does not classify PIT as profit taxes.

24,500 euros, t_{LBT}^{fed} was raised by one percentage point so that the full basic federal rate of 5.0% had to be paid only for taxable income exceeding 72,500 euros. The tax rate for a non-corporate firms $\tau^{non-corp}$ from 1998 to 2007, is $\tau^{non-corp} = \frac{\tau_{PIT} \cdot (1+soli) + t_{LBT}^{fed} \cdot \theta_{LBT}^{mun}}{1+t_{LBT}^{fed} \times 1.8}$. The denominator of the equation shows that a fixed share of the LBT liabilities can be deducted from the personal income tax base. This share amounted to $t_{LBT}^{fed} \cdot 1.8 \cdot Y$ from 2001 to 2007 and $t_{LBT}^{fed} \cdot 3.8 \cdot Y$ from 2008 onwards.

B.2 German labor market institutions

Traditionally, German labor unions have been very influential.[52] Collective bargaining agreements (CBAs) at the sector-level are the most important mechanism for wage determination. Nevertheless, there has been a significant decline in bargaining coverage. In West (East) Germany, CBA coverage decreased from 76% (63%) in 1998 to 65% (51%) in 2009. The share of workers covered by sectoral agreements fell from 68% (52%) to 56% (38%) (Ellguth, Gerner and Stegmaier, 2012).[53] In addition to sector-level CBA, some firms have firm-level agreements, while other firms are not covered by a CBA and rely on individual contracts with each employee.

The average duration of a CBA increased from 12 months in 1991 to 22 months in 2011. Usually, negotiations take place in the first half of a year. Firms may pay wages above those negotiated in CBAs. Except for a few industries, there was no legal minimum wage in Germany during our period of analysis. However, the social security and welfare system provides an implicit minimum wage and CBAs ensure that wages are above that level.

[52] See Dustmann et al. (2014) for an overview and analysis of the development of German labor market institutions during our period of investigation.

[53] Coverage rates vary by industry: collective bargaining is slightly above average in the manufacturing sector, while the highest coverage is in the public sector and the lowest in ICT, agriculture and restaurant industries. Overall, union coverage rates in Germany are lower than in other European countries – except the UK and some Eastern European countries – but higher than in the US (Du Caju et al., 2008).

C Descriptive Statistics

Jurisdictional changes Analogously to Figure 1, Figure C.1 shows the cross-sectional and time variation in LBT rates for the full sample of municipalities, including municipalities that underwent a jurisdictional change. The right panel clearly shows that the number of tax changes for these merged municipalities is relatively high. However, the variation in tax rates is artificial and related to the way we impute tax rates. As described in Section 2.2, the wage data contains geographical information for the jurisdictional boundaries as of December 31, 2010. In order to match the tax data, we have to bring it to the same boundaries. This generates artificial variation in tax rates, as we need to calculate population weighted average tax rates for those merged jurisdictions.

Consequently, we find a large number of (small) tax changes for East German municipalities. Table C.3 shows that on average 12.4% of the municipalities change their tax rate per year. Among the merged municipalities, however, the share is 33% (with a much smaller average change). Given this measurement error in tax rate changes, we focus on non-merged municipalities in our baseline analysis (and check whether results for merged and non-merged municipalities differ). Due to this restriction, we are left with about 10,000 municipalities and 18,000 tax changes for identification (instead of 11,441 municipalities with about 27,000 partly artificial tax changes).

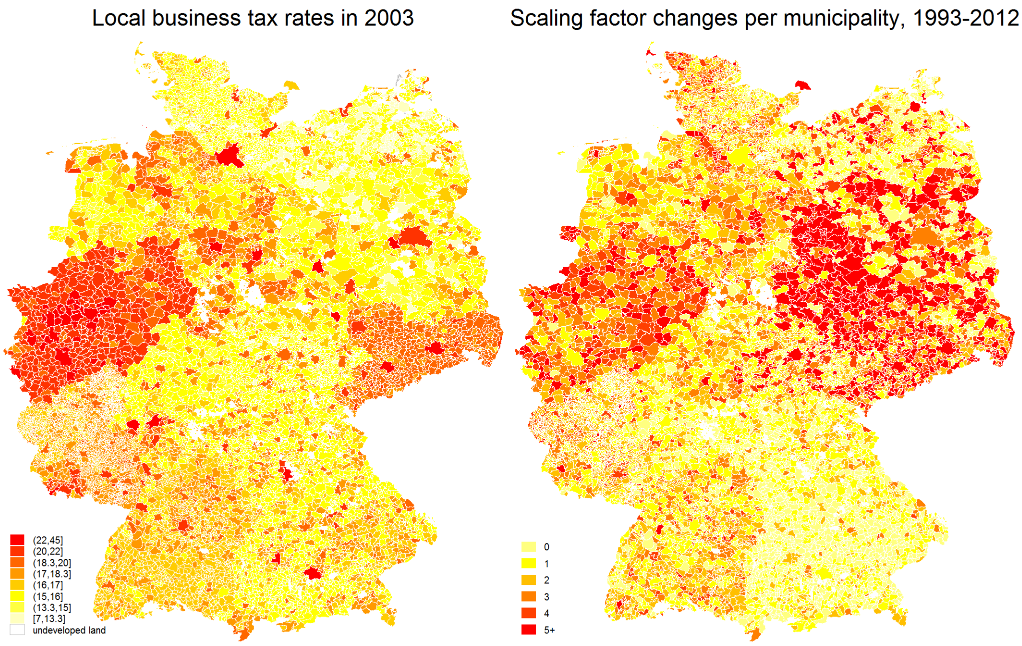


Figure C.1: Cross-sectional and time variation in local tax rates

Source: Statistical Offices of the Laender. Maps: GeoBasis-DE / BKG 2015. *Notes:* This figure shows the cross-sectional and time variation in municipal scaling factors of the German LBT. This figure includes both non-merged and merged municipalities. The left graph depicts the cross-sectional variation in LBT rates (in %) induced by different scaling factors for 2003 (the mid-year of our sample). The right graph indicates the number of scaling factor changes per municipality between 1993 and 2012. Jurisdictional boundaries are as of December 31, 2010.

Table C.1: Municipal scaling factors, 1993-2012

	mean	min	p5	p50	p95	max
1993	3.12	2.00	2.50	3.10	3.70	7.37
1994	3.15	2.00	2.59	3.13	3.72	5.15
1995	3.17	2.00	2.60	3.20	3.80	5.15
1996	3.19	2.00	2.70	3.20	3.80	5.15
1997	3.21	2.00	2.70	3.20	3.80	5.15
1998	3.22	2.00	2.74	3.20	3.80	9.00
1999	3.23	2.00	2.75	3.20	3.80	9.00
2000	3.24	2.00	2.75	3.20	3.80	9.00
2001	3.26	2.00	2.75	3.27	3.80	9.00
2002	3.27	2.00	2.80	3.30	3.85	9.00
2003	3.29	2.00	2.80	3.30	4.00	9.00
2004	3.31	2.00	2.80	3.30	4.00	9.00
2005	3.33	2.00	2.85	3.30	4.00	9.00
2006	3.34	2.00	2.90	3.30	4.00	9.00
2007	3.34	2.00	2.90	3.30	4.00	9.00
2008	3.35	2.00	2.90	3.30	4.00	9.00
2009	3.36	2.00	2.90	3.35	4.00	9.00
2010	3.38	2.00	3.00	3.40	4.00	9.00
2011	3.44	2.00	3.00	3.50	4.00	9.00
2012	3.47	2.00	3.00	3.50	4.03	9.00
Average	3.28	2.00	2.80	3.30	3.95	9.00

Source: Statistical Offices of the Laender. *Notes:* The table provides descriptive statistics on the municipal scaling factors for all non-merged municipalities (N=10001) in Germany over time.

Table C.2: Municipal scaling factors changes per municipality, 1993-2012

	any increase		large increases	
changes	municipalities	in %	municipalities	in %
all municipalities (N=11,441)				
0	2041	17.80	6969	60.90
1	3218	28.10	3583	31.30
2	3091	27.00	784	6.90
3	1667	14.60	95	0.80
4	720	6.30	9	0.10
5+	704	6.20	1	0.00
all non-merged municipalities (N=10,001)				
0	1902	19.00	6358	63.60
1	3025	30.20	3012	30.10
2	2862	28.60	566	5.70
3	1465	14.60	58	0.60
4	536	5.40	6	0.10
5+	211	2.10	1	0.00
non-merged municipalities in LIAB (N=3,522)				
0	672	19.08	2290	65.02
1	1018	28.90	993	28.19
2	914	25.95	213	6.05
3	541	15.36	22	0.62
4+	377	10.70	4	0.11
all merged municipalities (N=1,440)				
0	139	9.70	611	42.40
1	193	13.40	571	39.70
2	229	15.90	218	15.10
3	202	14.00	37	2.60
4	184	12.80	3	0.20
5+	493	34.20	0	0.00

Source: Statistical Offices of the Laender. *Notes:* The table summarizes the number of tax increases and large tax increases for all, non-merged and merged municipalities from 1993 to 2012. Large increases are defined as the top 25% of the tax increase distribution, that is an increase of the business tax rate of 1.1 percentage points or more.

Table C.3: Time variation in municipal scaling factors, 1993–2012

municip. with a(n) ...	... change		... increase		... decrease	
	share	mean change	share	mean increase	share	mean decrease
all municip.	12.2	0.15	10.3	0.20	1.9	-0.14
non-merged municip. (all)	9.4	0.19	8.8	0.22	0.6	-0.30
non-merged municip. (LIAB)	10.2	0.17	9.4	0.21	0.8	-0.26
merged municip.	31.9	0.07	20.6	0.15	11.3	-0.08
by year (all non-merged municipalities)						
1994	10.9	0.18	10.0	0.23	0.9	-0.45
1995	15.5	0.19	14.9	0.22	0.6	-0.40
1996	11.2	0.16	10.7	0.19	0.5	-0.37
1997	8.5	0.17	8.0	0.21	0.5	-0.41
1998	8.7	0.18	8.2	0.21	0.5	-0.32
1999	4.2	0.13	3.6	0.20	0.6	-0.31
2000	8.7	0.13	7.8	0.17	0.8	-0.23
2001	12.8	0.14	11.7	0.18	1.1	-0.23
2002	8.3	0.17	7.8	0.20	0.4	-0.35
2003	9.6	0.19	9.2	0.21	0.4	-0.28
2004	8.4	0.19	8.1	0.21	0.3	-0.30
2005	11.5	0.17	11.0	0.19	0.5	-0.27
2006	8.3	0.13	7.4	0.18	0.9	-0.28
2007	4.0	0.10	3.2	0.19	0.8	-0.26
2008	4.0	0.18	3.2	0.28	0.8	-0.26
2009	4.2	0.18	3.4	0.27	0.8	-0.20
2010	8.8	0.27	8.4	0.29	0.4	-0.22
2011	18.4	0.28	18.1	0.29	0.3	-0.21
2012	12.8	0.25	12.5	0.27	0.3	-0.30

Source: Statistical Offices of the Laender. *Notes:* The top part of the table summarizes the frequency, signs, and sizes of municipal scaling factor changes for all municipalities (N=11441), non-merged municipalities (N=10001), and merged municipalities (N=1440). The bottom part of the table shows the frequency, sign and size of municipal scaling factor changes for non-merged municipalities over time.

Table C.4: Percentiles of the share of non-wage-censored workers across firms

	p1	p5	p10	p25	p50	p75	p90	p95	p99	obs
manuf.	0.38	0.68	0.78	0.89	0.96	1	1	1	1	23,137
service	0.32	0.59	0.73	0.88	0.98	1	1	1	1	21,490
total	0.36	0.63	0.75	0.89	0.97	1	1	1	1	44,627

Source: LIAB. *Notes:* This table shows the distribution of the share of non-wage-censored workers across firms in different sectors. Workers are defined as wage-censored if they earned more than the social security contributions earnings ceilings at least once in the sample. In this table, manufacturing includes construction and services include trade.

Table C.5: Descriptive statistics, plant sample, non-merged municipalities, 1999-2008

	mean	p50	sd
Wage	2,733	2,717	877
Local scaling factor	3.85	3.90	0.52
LBT rate (in %)	18.65	19.00	3.09
Municipal spending (in millions)	2,648	110	6,155
Municipal population	436,255	49,856	904,957
District unemployment rate	0.12	0.10	0.05
District GDP (in millions)	18,977	6,758	28,198
Share: West German municipalities	0.80	1.00	0.40
Number of employees	265	53	1,136
Share: Liable plants	0.64	1.00	0.48
Share: Sector level bargaining	0.56	1.00	0.50
Share: Firm level bargaining	0.08	0.00	0.28
Share: No collective bargaining	0.36	0.00	0.48
Share: Manufacturing	0.26	0.00	0.44
Share: Construction	0.08	0.00	0.26
Share: Trade	0.11	0.00	0.32
Share: Services	0.23	0.00	0.42
Share: Public/Utilities	0.32	0.00	0.45
Share: High profitability	0.37	0.00	0.48
Share: Medium profitability	0.34	0.00	0.47
Share: Low profitability	0.29	0.00	0.46
Share: Single plant firms	0.62	1.00	0.49
Share: German owner	0.94	1.00	0.24

Source: LIAB and Statistical Offices of the Laender. *Notes:* Total number of plant-year observations: 69,249. Number of plants: 21,253. All monetary variables in 2008 euros.

Table C.6: Descriptive statistics, worker sample, non-merged municipalities, 1999-2008

	mean	p50	sd
Wage	3,491	3,363	1,092
Local scaling factor	4.00	4.10	0.53
LBT rate (in %)	19.50	19.50	3.85
Municipal spending (in millions)	2,605	334	5,667
Municipal population	470,429	120,136	833,344
District unemployment rate	0.11	0.10	0.04
District GDP (in millions)	22,233	9,211	28,541
Share: West German municipalities	0.88	1.00	0.32
Number of employees	5,802	1,138	10,345
Share: Liable firms	0.73	1.00	0.44
Age	41	42	10
Share: Male	0.72	1.00	0.45
Share: High-skilled	0.14	0.00	0.34
Share: Medium skilled	0.71	1.00	0.45
Share: Blue collar	0.53	1.00	0.50
Share: Never censored individuals	0.81	1.00	0.39

Source: LIAB and Statistical Offices of the Laender. *Notes:* Number of person-year observations: 12,673,576. Number of individuals: 4,091,932. All monetary variables in 2008 euros.

D Additional Results

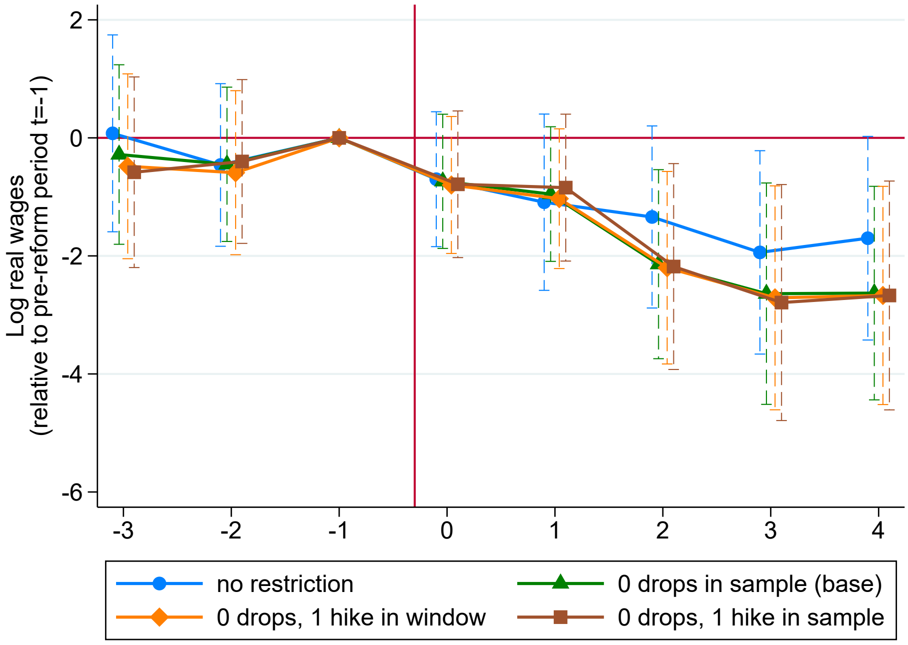


Figure D.1: Event study graphs: wage effects by event window cut

Source: LIAB and Statistical Offices of the Laender. *Notes:* The graph plots event study estimates ($\hat{\gamma}_j, j \in [-3, 4]$) and corresponding 95% confidence bands of different specifications of equation (1). Dependent variable is the log median firm wage (observed on 30 June for each year). Event dummies are equal to one for tax increases greater than or equal to the 75th percentile of the tax increase distribution. The tax change occurred for the treatment group on 1 January in event year $t = 0$, as indicated by the vertical red line. All regression models include municipal, firm and "state × year" fixed effects. The estimation sample comprises all establishments liable to the LBT in non-merged municipalities. Depending on the specification, we additionally restrict the sample to municipalities without a tax decrease during the observation period, not more than one increase in the event window, and/or only one tax increase in the whole observation period (see legend). Standard errors are clustered at the municipal level. Estimates are reported in Table D.11.

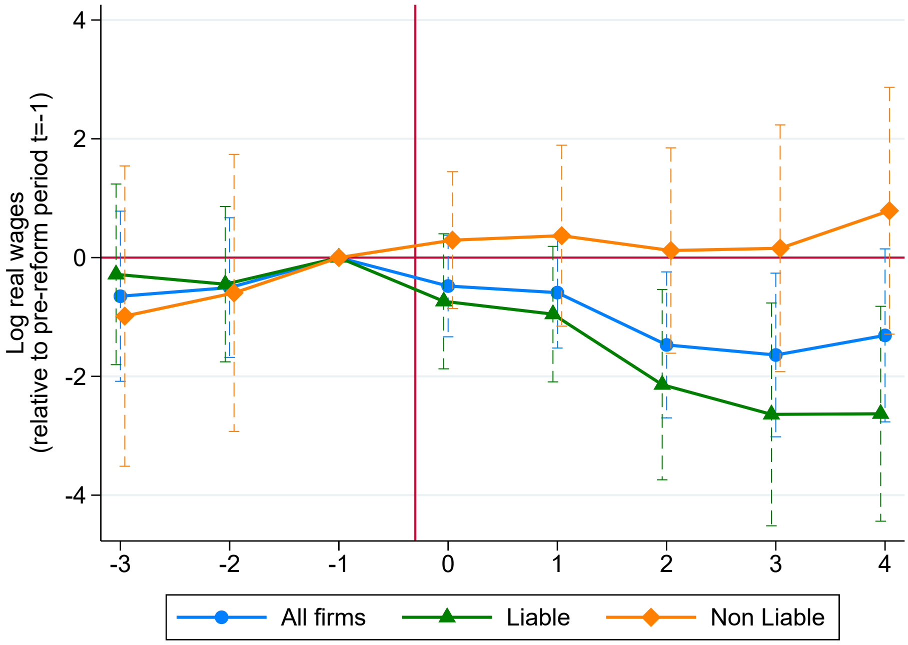


Figure D.2: Event study graphs: wage effects by firm liability

Source: LIAB and Statistical Offices of the Laender. *Notes:* The graph plots event study estimates ($\hat{\gamma}_j, j \in [-3, 4]$) and corresponding 95% confidence bands of different specifications of equation (1). Dependent variable is the log median firm wage (observed on 30 June for each year). Event dummies are equal to one for tax increases greater than or equal to the 75th percentile of the tax increase distribution. The tax change occurred for the treatment group on 1 January in event year $t = 0$, as indicated by the vertical red line. All regression models include municipal, firm and "state $\times$ year" fixed effects. The estimation sample comprises all establishments in non-merged municipalities that did not experienced a tax decrease during the observation period. Depending on the specification, we additionally restrict the sample to firms that are liable to or exempt from the LBT (see legend). Standard errors are clustered at the municipal level. Estimates are reported in Table D.12.

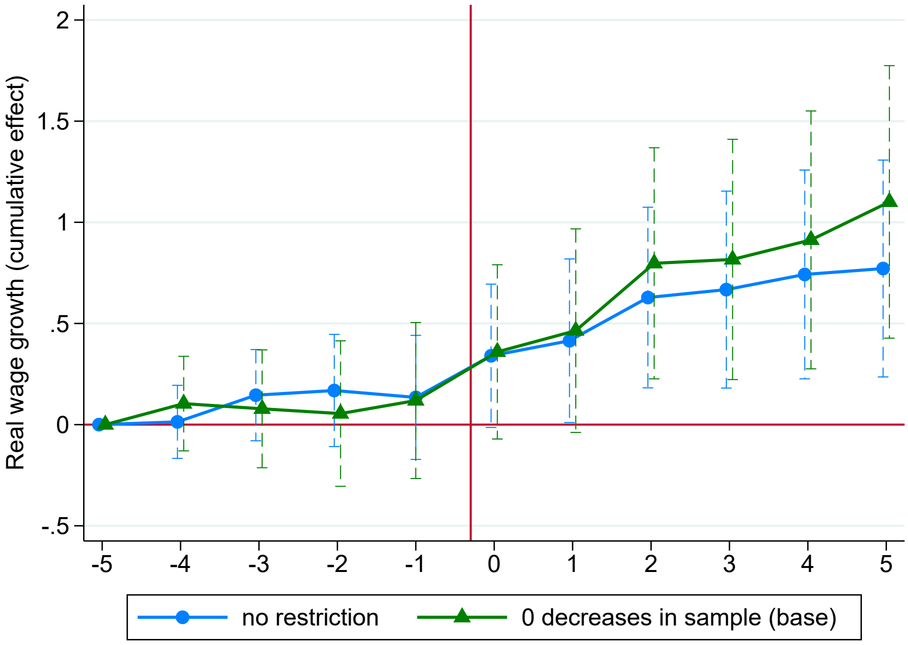
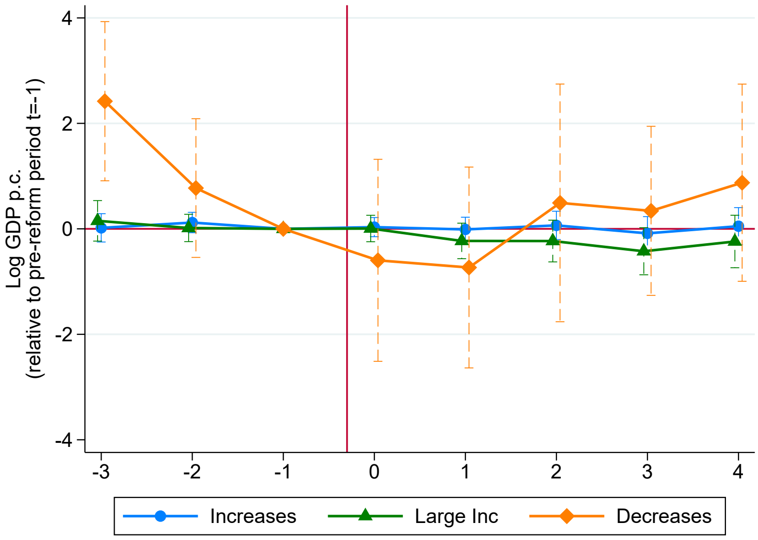


Figure D.3: Distributed lag model estimates: wage effects by event window cut

Source: LIAB and Statistical Offices of the Laender. *Notes:* The graph plots distributed lag model estimates ($\hat{\beta}_j, j \in [-4, 5]$) and corresponding 95% confidence bands of different specifications of equation (2). Dependent variable is the yearly change in the log median firm wage (observed on 30 June for each year). Main regressors are leads and lags of the yearly change in the net-of-local-business-tax rate. All regression models include municipal, firm and "state × year" fixed effects. The estimation sample comprises all establishments liable to the LBT in non-merged municipalities. Depending on the specification, we additionally restrict the sample to municipalities without a tax decrease during the observation period, not more than one increase in the event window, and/or only one tax increase in the whole observation period (see legend). Standard errors are clustered at the municipal level. Estimates are reported in Table D.14.

Panel A: GDP



Panel B: Unemployment

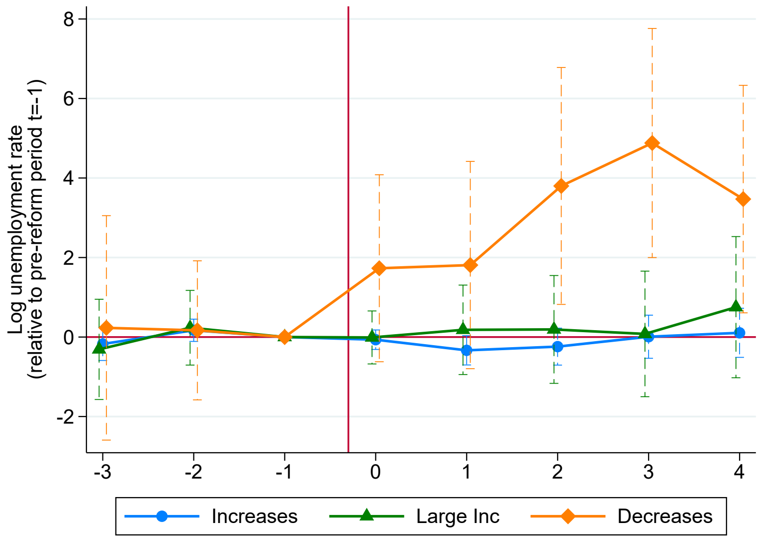
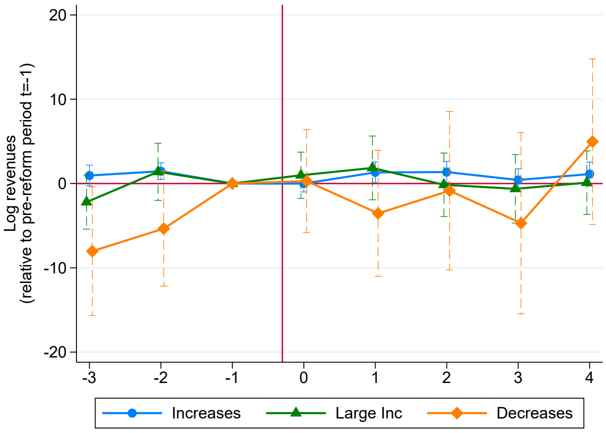


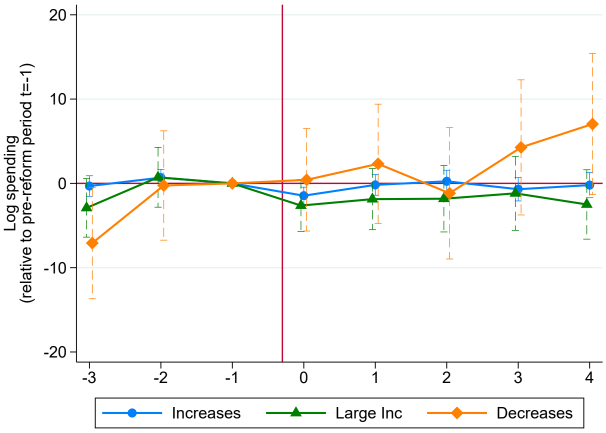
Figure D.4: Event study graphs: local business cycle effects including tax decreases

Source: Statistical Offices of the Laender. *Notes:* The graph plots event study estimates ($\hat{\gamma}_j, j \in [-3, 4]$) and corresponding 95% confidence bands of different specifications of equation (1). Dependent variables are log county GDP per capita (Panel A) and unemployment rate (Panel B). Event variables are dummies equal to one for a tax increase, a large tax increase (greater than or equal to the 75th percentile of the tax increase distribution), or a tax decrease (see legend). The tax change occurred for the treatment group on 1 January in event year $t = 0$, as indicated by the vertical red line. All regression models include municipal and "state $\times$ year" fixed effects. In specifications with tax increase (decrease) dummies, we exclude all municipalities that experienced a tax decrease (increase) during the observation period. Standard errors are clustered at the municipal level. Estimates are reported in Tables D.15 and D.16, respectively.

Panel A: Revenues



Panel B: Spending



Panel C: Fiscal surplus

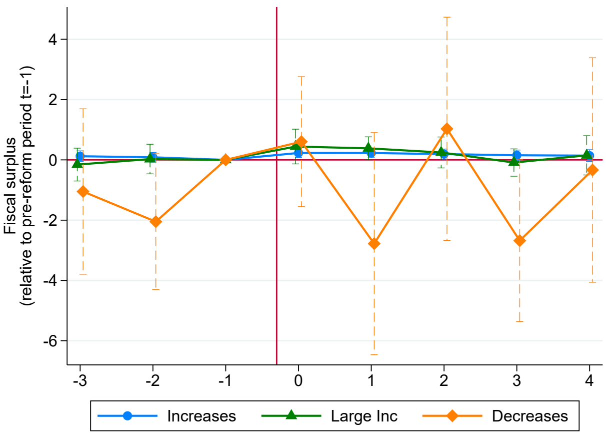


Figure D.5: Event study graphs: municipal fiscal budget variables

Source: Statistical Offices of the Laender. *Notes:* The graph plots event study estimates ($\hat{\gamma}_j, j \in [-3, 4]$) and corresponding 95% confidence bands of different specifications of equation (1). Dependent variables are log municipal revenues per capita (Panel A), log municipal spending per capita (Panel B), and municipal fiscal surplus, i.e. revenues – spending, per capita (Panel C). Event variables are dummies equal to one for a tax increase or a large tax increase (greater than or equal to the 75th percentile of the tax increase distribution, see legend). The tax change occurred for the treatment group on 1 January in event year $t = 0$, as indicated by the vertical red line. All regression models include municipal and "state × year" fixed effects. We exclude all municipalities that experienced a tax decrease during the observation period. Standard errors are clustered at the municipal level. Estimates are reported in Tables D.17, D.18, and D.19 respectively.

Table D.1: Differences-in-differences estimates: wage effects at different levels of aggregation

	(1)	(2)	(3)
Aggregation level	worker	firm	municipality
Log net-of-LBT rate	0.374	0.388	0.416
	(0.114)	(0.127)	(0.252)
N	9,295,488	44,654	15,433

Source: LIAB and Statistical Offices of the Laender. *Notes:* This table presents the DiD estimates $\hat{\delta}$ of regression model (3), estimated on different levels of aggregation as indicated at the top of the table. Dependent variable at the worker levels is the log individual wage, at the municipal level the log mean municipal wage. Coefficients measure the wage elasticity with respect to the net-of-local-business-tax rate. All specifications include municipal fixed effects, as well as "state × year" fixed effects. The model at the firm level additionally includes firm fixed effects, at the individual firm and worker fixed effects are added. The estimation sample comprises ([workers in] establishments in) non-merged municipalities. Standard errors are clustered at the municipal level. Standard errors are clustered at the municipal level. Specification (2) replicates the baseline estimate, presented in column (1) of Table 1.

Table D.2: Differences-in-differences estimates: effects on worker composition

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent var.	ln share high-skilled	ln share med-skilled	ln share male	ln share full-time	ln share blue-collar	ln mean age
Log net-of-LBT rate	0.054	−0.161	0.001	−0.139	0.425	−0.108
	(0.648)	(0.224)	(0.176)	(0.170)	(0.309)	(0.062)
N	22,978	44,289	43,446	44,654	40,115	44,654

Source: LIAB and Statistical Offices of the Laender. *Notes:* This table presents the DiD estimates $\hat{\delta}$ of regression model (3). Instead of the log wage, the dependent variables are log worker shares at the firm level, and the log mean worker age as indicated at the top of the table. Coefficients measure the wage elasticity with respect to the net-of-local-business-tax rate. All specifications include firm and municipal fixed effects, as well as "state × year" fixed effects. The estimation sample comprises all establishments liable to the LBT in non-merged municipalities. Standard errors are clustered at the municipal level.

Table D.3: Differences-in-differences estimates: robustness of wage effects to other controls

	(1)	(2)	(3)
Log net-of-LBT rate	0.388	0.436	0.476
	(0.127)	(0.138)	(0.131)
Future muni. spending		✓	
Share never-censored			✓
N	44,654	40,558	44,654

Source: LIAB and Statistical Offices of the Laender. *Notes:* This table presents the DiD estimates $\hat{\delta}$ of regression model (3). Coefficients measure the wage elasticity with respect to the net-of-local-business-tax rate. All specifications include firm and municipal fixed effects, as well as "state $\times$ year" fixed effects. In addition, control variables are added as indicated at the bottom of the table: (i) current and future (lead 1 and 2) municipal spending, (ii) the share of workers in the firm that are never wage-censored during the observation period. The estimation sample comprises all establishments liable to the LBT in non-merged municipalities. Standard errors are clustered at the municipal level. Specification replicates the baseline estimate, presented in column (1) of Table 1.

Table D.4: Differences-in-differences estimates at firm level: robustness to other dependent variables

	(1)	(2)	(3)	(4)
Log net-of-LBT rate	0.388	0.220	0.317	0.152
	(0.127)	(0.104)	(0.136)	(0.166)
Dep. var: log firm wage	P50	Mean	P25	P75
N	44,654	44,654	44,654	44,654

Source: LIAB and Statistical Offices of the Laender. *Notes:* This table presents the DiD estimates $\hat{\delta}$ of regression model (3). The dependent variable are specific measures (median, mean, p25, p75) of the firm wage (in logs), as indicated at the top of the table. Coefficients measure the wage elasticity with respect to the net-of-local-business-tax rate. All specifications include firm and municipal fixed effects, as well as "state $\times$ year" fixed effects.The estimation sample comprises all establishments liable to the LBT in non-merged municipalities. Standard errors are clustered at the municipal level. Specification (1) replicates the baseline estimate, presented in column (1) of Table 1.

Table D.5: Differences-in-differences estimates: robustness of wage effects to different estimation samples

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log net-of-LBT rate	0.388	0.185	0.188	0.409	0.406	0.408	0.367
	(0.127)	(0.097)	(0.102)	(0.146)	(0.122)	(0.151)	(0.143)
Municipalities	Non-merged	Non-merged	All	Non-merged	Non-merged	Non-merged	Non-merged
Firms	Liable	All	Liable	Liable	Liable	Liable	Liable
Years	99-08	99-08	99-08	99-08	99-08	99-08	99-07
Add. condition				0 drops	+ incorp. changers	+ firms < 4 workers	
N	$44,654$	$69,249$	$58,062$	$36,828$	$49,886$	$56,066$	$39,975$

Source: LIAB and Statistical Offices of the Laender. *Notes:* This table presents the DiD estimates $\hat{\delta}$ of regression model (3). Coefficients measure the wage elasticity with respect to the net-of-local-business-tax rate. All specifications include firm and municipal fixed effects, as well as "state × year" fixed effects. The estimation sample varies across specifications as indicated at the bottom of the table. Standard errors are clustered at the municipal level. Specification (1) replicates the baseline estimate, presented in column (1) of Table 1.

Table D.6: Differences-in-differences estimates: wage effects at individual level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log net-of-LBT rate	0.374	0.347	0.353	0.414	0.298	0.361	0.468	0.367
	(0.114)	(0.087)	(0.104)	(0.116)	(0.173)	(0.114)	(0.144)	(0.116)
Workers	ft	ft	ft	ft	ft	ft	non-cens	ft+pt
State × year FE	✓			✓	✓	✓	✓	✓
Year FE		✓						
CZ × year FE			✓					
Municipal controls $t-2$				✓				
Firm controls $t-2$					✓			
Worker characteristics						✓		
N (in million)	9.295	9.295	9.295	9.295	6.430	9.295	7.275	10.091

Source: LIAB and Statistical Offices of the Laender. *Notes:* This table presents the DiD estimates $\hat{\delta}$ of regression model (3) with the log individual wage as dependent variable. Coefficients measure the wage elasticity with respect to the net-of-local-business-tax rate. All regression models include municipal, firm and worker fixed effects. Additional control variables and fixed effects (year, "state × year" or "commuting zone (CZ) × year") vary depending on the specification (as indicated at the bottom of the table). For specifications (1) to (6), the estimation sample comprises all full-time (ft) workers in establishments liable to the LBT in non-merged municipalities. In model (7), the sample is restricted to workers whose wages have never been right-censored at the ceiling for social security contributions. In specification (8), part-time workers are added to the full-time worker sample.

Table D.7: Differences-in-differences estimates: robustness of wage effects with respect to clustering

	(1)	(2)	(3)	(4)	(5)	(6)
Log net-of-LBT rate	0.388	0.388	0.388	0.388	0.388	0.388
	(0.127)	(0.091)	(0.129)	(0.131)	(0.119)	(0.129)
N	44,654	44,654	44,654	44,654	44,654	44,654
Clustering at level of	muni	muni×year	county	CZ	state	firm
Clusters	2,820	14,610	394	253	16	14,221

Source: LIAB and Statistical Offices of the Laender. *Notes:* This table presents the DiD estimates $\hat{\delta}$ of regression model (3). Coefficients measure wage the elasticity with respect to the net-of-local-business-tax rate. All specifications include firm and municipal fixed effects, as well as "state × year" fixed effects. The estimation sample comprises all establishments liable to the LBT in non-merged municipalities. Standard errors are clustered at different levels as indicated at the bottom of the table. Our preferred specification is shown in column (1), where standard errors are clustered at the municipal level.

Table D.8: Differences-in-differences estimates: wage effects by worker type, robustness with respect to censoring

Stratified by ...	Effect of the log net-of-LBT rate by worker type			N
Skill	High	Medium	Low	
All workers	0.013	0.357	0.377	9,295,488
	(0.120)	(0.115)	(0.168)	
Not wage-censored	0.011	0.431	0.428	7,275,134
	(0.230)	(0.139)	(0.192)	
Gender	Female	Male		
All workers	0.530	0.325		9,295,488
	(0.129)	(0.119)		
Not wage-censored	0.583	0.429		7,275,134
	(0.140)	(0.153)		
Occupation	Blue-collar	White-collar		
All workers	0.363	0.250		9,295,422
	(0.132)	(0.104)		
Not wage-censored	0.424	0.333		7,275,090
	(0.161)	(0.128)		
Age	Young	Medium	Old	
All workers	0.507***	0.317***	0.329***	9,295,488
	(0.127)	(0.111)	(0.106)	
Not wage-censored	0.526	0.370	0.401	7,275,134
	(0.151)	(0.136)	(0.124)	

Source: LIAB and Statistical Offices of the Laender. *Notes:* This table presents the DiD estimates $\hat{\delta}$ of regression model (3) with the log individual wage as dependent variables for different worker types as indicated in the table. The heterogeneous effects are estimated by interacting the LBT rate with dummy variables for different firms types. Coefficients measure the wage elasticity with respect to the net-of-local-business-tax rate. All specifications include worker, firm and municipal fixed effects, as well as "state × year" and "firm type × year" fixed effects. The estimation sample comprises all establishments liable to the LBT in non-merged municipalities. Standard errors are clustered at the municipal level.

Table D.9: Effect of incidence assumptions on average tax rates across income distribution

Groups	PIT	CIT	Total	Ratio	PIT	CIT	Total	Ratio
	US (2004)				**Germany (2015)**			
Population average	11.5	2.3	13.7		12.3	2.0	14.4	
Panel A: Piketty-Saez Baseline (CIT incidence: 0% wages, 100% capital)								
P0-90	5.4	1.5	7.0		5.5	0.2	5.7	
P90-100	14.7	2.3	16.9	1.4	21.8	2.7	24.6	4.3
P99-100	22.7	4.0	26.8	2.9	27.4	7.4	34.8	6.1
Panel B: Counterfactual 1 (CIT incidence: 50% wages, 50% capital)								
P0-90	5.4	2.4	7.8		5.5	1.2	6.7	
P90-100	14.7	1.1	15.8	1.0	21.8	1.4	23.2	3.5
P99-100	22.7	2.0	24.8	2.2	27.4	3.7	31.1	4.6
Panel C: Counterfactual 2 (CIT incidence: 100% wages, 0% capital)								
P0-90	5.4	2.5	7.9		5.5	2.0	7.5	
P90-100	14.7	0.0	14.7	0.8	21.8	0.0	21.8	2.9
P99-100	22.7	0.0	22.7	1.9	27.4	0.0	27.4	3.7

Source: Own calculations based on Piketty and Saez (2007) for the US-2004 and Bach, Beznoska and Steiner (2016) for Germany-2015. *Notes:* This table shows the average income tax rates for the bottom 90%, top 10% and top 1% of the market income distribution. The total tax rates are decomposed into personal and corporate income tax rates (PIT and CIT). The CIT for Germany includes the LBT. The "ratio" column reports the ratio of the top tax rate (top 10% or top 1%) to the tax rate for the bottom 90% as a measure of progressivity. Panel A reports tax rates under the incidence assumption of Piketty and Saez (2007), i.e. the full corporate tax incidence being on capital income. Panels B and C report two counterfactuals with 50% (100%) of the incidence on wages. Note that formula (4) calculates the share of the tax burden borne by workers in terms of welfare – as discussed in Section 3.2. Given that the back-of-the-envelope calculation reported in this table is meant for illustrative purposes only, we assume here for simplicity reasons that 50% (100%) of the effective tax burden is shifted onto workers. In both counterfactuals, the wage incidence is only affecting wages of workers in the the bottom 90% (in line with the heterogeneous effects that we find).

Table D.10: Event study estimates: baseline wage effects

Specification	(1) Increases	(2) Large Inc	(3) Decreases
F4	0.559	-0.435	0.231
	(0.352)	(0.816)	(1.110)
F3	0.423	-0.282	0.697
	(0.305)	(0.776)	(1.220)
F2	0.069	-0.448	0.916
	(0.228)	(0.667)	(0.876)
L0	-0.073	-0.736	1.370
	(0.206)	(0.580)	(0.724)
L1	-0.226	-0.952	0.279
	(0.281)	(0.582)	(0.907)
L2	-0.622	-2.140	0.490
	(0.309)	(0.817)	(0.799)
L3	-0.576	-2.640	0.674
	(0.318)	(0.957)	(0.710)
L4	-0.450	-2.630	-0.574
	(0.359)	(0.923)	(1.030)
L5	-0.899	-3.100	0.729
	(0.349)	(1.030)	(0.659)
N	36,826	36,826	6,001

Source: LIAB and Statistical Offices of the Laender. *Notes:* The table shows the event study estimates plotted in Panel A of Figure 3. Please refer to figure note for further information.

Table D.11: Event study estimates: wage effects by event window cut

Specification	(1) no res.	(2) 0D in S	(3) 0D, 1H in W	(4) 0D, 1H in S
F4	0.566	-0.435	-0.644	-0.807
	(0.935)	(0.816)	(0.839)	(0.851)
F3	0.077	-0.282	-0.481	-0.582
	(0.851)	(0.776)	(0.799)	(0.824)
F2	-0.459	-0.448	-0.590	-0.400
	(0.703)	(0.667)	(0.709)	(0.708)
L0	-0.700	-0.736	-0.798	-0.786
	(0.583)	(0.580)	(0.592)	(0.634)
L1	-1.090	-0.952	-1.030	-0.843
	(0.762)	(0.582)	(0.604)	(0.635)
L2	-1.340	-2.140	-2.200	-2.180
	(0.787)	(0.817)	(0.832)	(0.890)
L3	-1.940	-2.640	-2.710	-2.790
	(0.879)	(0.957)	(0.968)	(1.020)
L4	-1.700	-2.630	-2.670	-2.670
	(0.880)	(0.923)	(0.943)	(0.989)
L5	-2.030	-3.100	-3.280	-3.330
	(0.976)	(1.030)	(1.070)	(1.130)
N	44,630	36,826	36,086	33,554

Source: LIAB and Statistical Offices of the Laender. *Notes:* The table shows the event study estimates plotted in Figure D.1. Please refer to figure note for further information.

Table D.12: Event study estimates: wage effects by firm liability

Specification	(1) All firms	(2) Liable	(3) Non Liable
F4	-0.771	-0.435	-1.040
	(0.812)	(0.816)	(1.530)
F3	-0.651	-0.282	-0.985
	(0.731)	(0.776)	(1.290)
F2	-0.505	-0.448	-0.595
	(0.600)	(0.667)	(1.190)
L0	-0.479	-0.736	0.294
	(0.436)	(0.580)	(0.588)
L1	-0.590	-0.952	0.369
	(0.476)	(0.582)	(0.777)
L2	-1.470	-2.140	0.119
	(0.627)	(0.817)	(0.882)
L3	-1.640	-2.640	0.157
	(0.703)	(0.957)	(1.060)
L4	-1.310	-2.630	0.789
	(0.743)	(0.923)	(1.060)
L5	-1.460	-3.100	1.400
	(0.790)	(1.030)	(1.240)
N	57,032	36,826	20,206

Source: LIAB and Statistical Offices of the Laender. *Notes:* The table shows the event study estimates plotted in Figure D.2. Please refer to figure note for further information.

Table D.13: Distributed lag model estimates: baseline wage effects

Specification	(1) Lead/Lag	(2) Lag
F4	0.104	
	(0.119)	
F3	-0.026	
	(0.128)	
F2	-0.023	
	(0.109)	
F1	0.064	
	(0.117)	
L0	0.236	0.237
	(0.115)	(0.115)
L1	0.109	0.111
	(0.152)	(0.152)
L2	0.333	0.327
	(0.158)	(0.158)
L3	0.019	0.013
	(0.152)	(0.151)
L4	0.097	0.104
	(0.151)	(0.151)
L5	0.188	0.186
	(0.126)	(0.126)
N	24,626	24,626

Source: LIAB and Statistical Offices of the Laender. *Notes:* The table shows the estimates of the distributed lag model whose cumulative effects are plotted in Panel B of Figure 3. Please refer to figure note for further information.

Table D.14: Distributed lag model estimates: wage effects by event window cut

Specification	(1) no res.	(2) 0D in S
F4	0.014	0.104
	(0.092)	(0.119)
F3	0.132	-0.026
	(0.103)	(0.128)
F2	0.023	-0.023
	(0.093)	(0.109)
F1	-0.034	0.064
	(0.110)	(0.117)
L0	0.206	0.236
	(0.101)	(0.115)
L1	0.074	0.109
	(0.109)	(0.152)
L2	0.214	0.333
	(0.115)	(0.158)
L3	0.039	0.019
	(0.117)	(0.152)
L4	0.075	0.097
	(0.113)	(0.151)
L5	0.029	0.188
	(0.100)	(0.126)
N	29,634	24,626

Source: LIAB and Statistical Offices of the Laender. *Notes:* The table shows the estimates of the distributed lag model whose cumulative effects are plotted in Figure D.3. Please refer to figure note for further information.

Table D.15: Event study estimates: GDP

Specification	(1) Increases	(2) Large Inc	(3) Decreases
F4	-0.146	0.134	2.310
	(0.164)	(0.241)	(1.080)
F3	0.019	0.152	2.420
	(0.137)	(0.196)	(0.770)
F2	0.119	0.016	0.773
	(0.099)	(0.132)	(0.671)
L0	0.033	0.006	-0.597
	(0.093)	(0.128)	(0.977)
L1	-0.011	-0.229	-0.733
	(0.118)	(0.172)	(0.972)
L2	0.066	-0.231	0.492
	(0.137)	(0.202)	(1.150)
L3	-0.085	-0.425	0.341
	(0.162)	(0.228)	(0.818)
L4	0.050	-0.240	0.875
	(0.180)	(0.254)	(0.954)
L5	0.115	-0.450	0.048
	(0.197)	(0.278)	(1.030)
N	31,023	31,023	6,479

Source: LIAB and Statistical Offices of the Laender. *Notes:* The table shows the event study estimates plotted in Panel A of Figure 4. Please refer to figure note for further information.

Table D.16: Event study estimates: unemployment

Specification	(1) Increases	(2) Large Inc	(3) Decreases
F4	-0.364	-0.863	-0.112
	(0.284)	(0.767)	(1.640)
F3	-0.174	-0.310	0.231
	(0.212)	(0.643)	(1.440)
F2	0.170	0.234	0.168
	(0.143)	(0.479)	(0.892)
L0	-0.067	-0.010	1.730
	(0.125)	(0.340)	(1.200)
L1	-0.334	0.182	1.810
	(0.188)	(0.574)	(1.330)
L2	-0.241	0.191	3.800
	(0.237)	(0.692)	(1.520)
L3	0.008	0.079	4.880
	(0.277)	(0.806)	(1.470)
L4	0.106	0.751	3.470
	(0.315)	(0.906)	(1.460)
L5	-0.003	1.710	2.250
	(0.337)	(0.975)	(2.320)
N	31,023	31,023	6,479

Source: LIAB and Statistical Offices of the Laender. *Notes:* The table shows the event study estimates plotted in Panel B of Figure 4. Please refer to figure note for further information.

Table D.17: Event study estimates: municipal revenues

Specification	(1) Increases	(2) Large Inc	(3) Decreases
F4	1.150	0.659	-8.820
	(0.663)	(1.910)	(4.470)
F3	0.949	-2.200	-8.030
	(0.627)	(1.640)	(3.900)
F2	1.460	1.390	-5.350
	(0.509)	(1.730)	(3.480)
L0	-0.008	0.980	0.288
	(0.506)	(1.400)	(3.110)
L1	1.320	1.850	-3.540
	(0.624)	(1.930)	(3.820)
L2	1.360	-0.148	-0.851
	(0.647)	(1.920)	(4.800)
L3	0.421	-0.629	-4.700
	(0.676)	(2.070)	(5.490)
L4	1.120	0.102	4.970
	(0.722)	(1.920)	(5.010)
L5	1.830	1.660	-3.090
	(0.748)	(2.040)	(3.900)
N	30,984	30,984	6,477

Source: LIAB and Statistical Offices of the Laender. *Notes:* The table shows the event study estimates plotted in Panel A of Figure D.5. Please refer to figure note for further information.

Table D.18: Event study estimates: municipal spending

Specification	(1) Increases	(2) Large Inc	(3) Decreases
F4	-0.169	-0.255	-6.010
	(0.689)	(2.040)	(2.930)
F3	-0.313	-2.910	-7.080
	(0.623)	(1.770)	(3.370)
F2	0.682	0.720	-0.251
	(0.501)	(1.810)	(3.310)
L0	-1.460	-2.630	0.421
	(0.515)	(1.580)	(3.100)
L1	-0.178	-1.870	2.320
	(0.629)	(1.850)	(3.610)
L2	0.246	-1.820	-1.170
	(0.667)	(2.010)	(3.980)
L3	-0.692	-1.180	4.270
	(0.709)	(2.240)	(4.090)
L4	-0.203	-2.500	7.040
	(0.765)	(2.100)	(4.270)
L5	0.046	0.547	-2.520
	(0.798)	(2.240)	(3.610)
N	30,982	30,982	6,476

Source: LIAB and Statistical Offices of the Laender. *Notes:* The table shows the event study estimates plotted in Panel B of Figure D.5. Please refer to figure note for further information.

Table D.19: Event study estimates: municipal fiscal surplus

Specification	(1) Increases	(2) Large Inc	(3) Decreases
F4	0.169	0.110	-1.330
	(0.090)	(0.263)	(1.310)
F3	0.121	-0.156	-1.050
	(0.091)	(0.278)	(1.400)
F2	0.086	0.027	-2.050
	(0.081)	(0.251)	(1.150)
L0	0.230	0.442	0.604
	(0.078)	(0.294)	(1.100)
L1	0.228	0.383	-2.780
	(0.079)	(0.194)	(1.880)
L2	0.192	0.246	1.030
	(0.085)	(0.262)	(1.890)
L3	0.153	-0.089	-2.680
	(0.088)	(0.231)	(1.370)
L4	0.141	0.150	-0.336
	(0.100)	(0.332)	(1.900)
L5	0.255	-0.081	-0.080
	(0.095)	(0.252)	(1.200)
N	30,983	30,983	6,477

Source: LIAB and Statistical Offices of the Laender. *Notes:* The table shows the event study estimates plotted in Panel C of Figure D.5. Please refer to figure note for further information.