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

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Abstract

This paper estimates the incidence of corporate taxes on wages using a 20-year panel of German municipalities. Administrative linked employer-employee data allows estimating heterogeneous firm and worker effects. We set up a general theoretical framework showing that corporate taxes can have a negative effect on wages in various labor market models. Using event study designs and differences-in-differences models, we test the theoretical predictions. Our results indicate that workers in liable firms bear about 47% of the total tax burden. Empirically, we confirm the importance of labor market institutions and profit shifting possibilities for the incidence of corporate taxes on wages.

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1 Introduction

Most economists think that labor bears part of the burden of corporate taxation.[1] However, there is considerable disagreement over how much of the corporate tax burden is shifted onto workers. The theoretical literature, inspired by the seminal contribution of Harberger (1962), predicts that the incidence on wages depends on assumptions regarding the openness of the economy (Diamond and Mirrlees, 1971a,b; Bradford, 1978; Kotlikoff and Summers, 1987; Harberger, 1995), its sectoral composition (Shoven, 1976), savings behavior (Feldstein, 1974; Bradford, 1978) and the presence of uncertainty in the economy (Ratti and Shome, 1977).[2] Little attention has been paid to the role of wage-setting institutions and labor market frictions. With the exception of Felix and Hines (2009) and Arulampalam et al. (2012), who study corporate taxes in a wage bargaining context, existing studies assume a competitive labor market.

Credible empirical evidence on the incidence of corporate taxes is scarce. Sufficient and exogenous variation in corporate tax rates is essential for identifying the causal effect of higher corporate taxes. Cross-country research designs[3] need to defend their (implicit or explicit) common trend assumptions. Single-country designs can establish a valid control group more easily. Most existing studies[4], however, have to rely on variation in the tax burden that is not driven solely by policy reforms but also by firms' choices. For instance, differences in tax burdens across industries or due to formula apportionment may depend directly on sales and investment activities which might be endogenous to tax rates as well. In a recent contribution, Suarez Serrato and Zidar (2016) calibrate a spatial equilibrium model based on reduced-form estimates exploiting changes in tax rate differentials and variation from formula apportionment weights across U.S. federal states.[5]

In this paper, we revisit the question of the incidence of corporate taxes on wages both theoretically and empirically. First, we develop a theoretical model that explicitly accounts for the role of wage-setting institutions and labor market frictions for the incidence of corporate taxation. Second, we exploit the specific institutional setting of the German local business tax (LBT) to identify the corporate tax incidence on wages.

[1] For example, public economists surveyed by Fuchs et al. (1998) respond on average that 40% of the corporate tax incidence is on capital (with an interquartile range of 20–65%) leaving a substantial share of the burden for labor (and land owners or consumers).

[2] Surveys of the literature are provided by Auerbach (2005) and Harberger (2006). Computational general equilibrium (CGE) models find that labor bears a substantial share of the corporate tax burden under reasonable assumptions (see Gravelle, 2013, for an overview).

[3] See e.g. Hassett and Mathur (2006); Felix (2007); Desai et al. (2007); Clausing (2013); Azémar and Hubbard (2015).

[4] See e.g. Dwenger et al. (2011); Arulampalam et al. (2012); Liu and Altshuler (2013).

[5] Felix and Hines (2009) also use U.S. state variation but rely on cross-sectional data.

In the first part of the paper, we set up a general theoretical framework that allows us to derive testable predictions for the effect of corporate tax changes on wages under different assumptions regarding wage-setting institutions and labor market frictions. In most settings, higher corporate taxes reduce wages, albeit for different reasons. This holds true in particular for models with individual and collective wage bargaining, fair wage models, models where higher wages allow firms to hire more productive workers and monopsonistic labor markets. However, the wage effects are diluted and may disappear completely i) if collective bargaining takes place at the sector-level, rather than the level of the individual firm, ii) if there is formula apportionment for firms operating in multiple jurisdictions or iii) if firms react to higher corporate taxes by shifting income to the personal income tax base or to other countries.

In the second part, we test the theoretical predictions using administrative panel data on German municipalities from 1993 to 2012. Germany is well-suited to test our theoretical model for several reasons. First, there is substantial tax variation at the local level. From 1993 to 2012, on average 12.4% of municipalities adjusted their LBT rates per year. Eventually, we exploit 17,999 tax changes in 10,001 municipalities between 1993 and 2012 for identification.[6] Compared to cross-country studies, the necessary common trend assumption is more likely to hold in our setting since municipalities are more comparable than countries. Second, municipalities can only change the LBT rate, while the tax base definition and liability conditions are determined at the federal level.[7] Hence, the variation in tax rates we exploit empirically does not depend on (current) firm choices. 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 substantial mobility of capital, labor and goods across municipal borders. General equilibrium effects on interest rates or consumer prices are therefore likely to be of minor importance in this setting. This is likely to be true even for sectors producing non-tradable goods, like the service sector, since individuals may buy these services in the neighboring municipality. Third, the German labor market is characterized by a variety of wage-setting institutions which include sector and firm-level collective bargaining as well as wage setting on the basis of contracts between firms and individual employees. In order to shed light on the specific interactions of labor market institutions and tax changes, we match the municipal data to administrative linked employer-employee micro data that combine social security

[6] Bauer et al. (2012) also investigate the LBT. However, as in an earlier version of this paper (Fuest et al., 2011), they average tax rates on the county level (consisting of 28 municipalities on average). Due to this aggregation, firms in unaffected municipalities are wrongly exposed to a change in the county's average tax rate leading to biased results. Moreover, Bauer et al. (2012) lack relevant firm data because they do not use linked employer-employee data.

[7] Kawano and Slemrod (2012) compare a large number of reforms of nationwide corporate taxes and show that tax rate change are usually combined with changes in the tax base as well.

records with a representative firm survey.

We apply event study designs and differences-in-differences (DiD) models to estimate the effect of corporate tax changes on wages and test our theoretical predictions. We find a negative overall effect of higher corporate taxes on wages. Averaging over all firms, a 1-euro increase in the tax bill, leads to a decrease of the wage bill by 29 cents. Focussing on firms liable to the LBT, the estimate increases to 61 cents.[8] Accounting for the marginal excess burden of the corporate tax, 22% (47%) of the total tax burden is borne by workers (in liable firms). Our findings are robust to the inclusion of a comprehensive set of very local and flexible controls suggesting that omitted variables such as local shocks are not driving the results.

In the next step, we estimate heterogeneous firm and worker effects to test the predictions generated by our theoretical analysis. First, we do not find any effects on 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 are rents in the labor market, due to collective bargaining for instance, wage responses are larger. Third, wage effects are close to zero for firms which operate in multiple jurisdictions, confirming the theoretical prediction that formula apportionment dilutes the effects of tax changes. Wages effects are also negligible in large firms and foreign owned firms. This may be explained by international profit-shifting opportunities available to these firms.

We contribute to the literature in several ways. First, we provide new estimates for the corporate tax incidence on wages exploiting the German institutional setting, which gives rise to substantial variation in tax rates. Second, going beyond the German case, our general theoretical analysis highlights the role of labor market institutions for tax incidence, which has not received much attention in the literature. The relevance of the different types of labor market frictions we consider differs across countries. While unions are strong in some countries, others exhibit more competitive labor markets, where individual wage bargaining is more relevant, as assumed in search and matching models.[9] Fair wage considerations or firms that set higher wages to hire more productive workers are also likely to be relevant in many countries. Third, our detailed linked employer-employee data allows us to investigate heterogeneous firm and worker effects and test many of our theoretical predictions. For instance, we observe firms with and without collective bargaining agreements, which allows us to empirically test the role of different

[8] Note that only very few nominal wage decreases are observable in the data. Our wage responses are rather driven by smaller nominal wage increases leading to lower future nominal wage levels in the treated municipalities.

[9] Unions are especially important in Northern and Continental European countries, as well as Australia, Canada, New Zealand and Mexico – see the OECD Trade Union Density statistics: `http://stats.oecd.org/Index.aspx?DataSetCode=UN_DEN`.

labor market frictions predicted by the theory. Furthermore, we find differences in tax incidence between small versus large firms and profitable versus less profitable firms, which are likely to be important in other countries as well. Last, we study corporate taxation at the subnational level, which is important in many countries.[10] Compared to changes in national corporate tax rates, two potential differences are worth noting. On the one hand, relative mobility of labor might be lower at the national level, which should lead to larger wage effects of tax changes. On the other hand, price effects are likely to be more important when looking at national tax changes. This should imply that a smaller share of the tax burden is shifted to labor.

The rest of the paper is structured as follows. In Section 2, we discuss the incidence of corporate taxes on wages in a broad theoretical framework, paying special attention to the interaction of labor market institutions and corporate taxation. In Section 3, we briefly describe the German institutional setting, in particular the corporate tax system focusing on the LBT, whose variation we exploit in the empirical part of the paper. The empirical model and the administrative linked employer-employee dataset used for the analysis are presented in Section 4. Empirical results are shown and discussed in Section 5. Section 6 presents our conclusions.

2 The theory of corporate tax incidence

The theoretical literature has produced various models of the 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.[11] The subsequent literature has emphasized the importance of international capital mobility in open economies. 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. 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

[10] For OECD countries, prominent examples include the U.S., Canada, France, Italy, Japan, Spain and Switzerland (see, e.g., Bird, 2003; Spengel et al., 2014, for overviews).

[11] 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.

burden will be fully shifted to owners of immobile factors like land or labor.[12]

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. We develop a simple theoretical framework that allows us to study corporate tax incidence with imperfect labor markets and both labor and capital mobility. Assume that profits of firm i, located in jurisdiction j, are given by

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

where p_i is the output price, F_i is a production function with declining returns to scale so that there are positive profits.[13] K_i is capital, r_i is the non-tax cost of capital, L_i^k is labor of skill type k and w_i^k the corresponding wage. The tax rate on corporate profits in jurisdiction j is denoted by τ_j. The parameter α describes the tax deductibility of capital costs. A cash-flow tax with perfect loss offset would imply $\alpha = 1$, that is full deductibility. 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 normalize the number of firms per jurisdiction to unity and 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

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

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 (1) 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,

[12] See e.g. Bradford (1978); Kotlikoff and Summers (1987); Harberger (2006). 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.

[13] We need the assumption of positive profits or some type of rent due to locational advantages or entrepreneurial skills for the wage bargaining models discussed further below. 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.[14]

2.1 Competitive labor markets

In a competitive labor market, corporate tax incidence depends on two factors: the relative mobility of production factors and the definition of the tax base. First, if labor is mobile across jurisdictions, a decline in wages in response to higher taxes would induce workers to seek employment in other jurisdictions. In the case of perfect labor mobility, the wage rates would be determined in the national labor market and local corporate tax changes would not affect wages. The tax burden would fall on land or reduce other location-specific rents (for given output prices). The assumption that mobility makes wages completely independent of local conditions is restrictive, however, and not just because of mobility costs. One reason why this may not hold is that local public services may affect migration decisions. If a corporate tax change leads to higher local public spending, workers might accept lower wages in return for better public services. Thus, higher taxes may lead to lower local wages if accompanied by more public services. We will investigate this issue in our empirical analysis. For given levels of public services, the effect of tax changes on wages depends on the price elasticities of labor supply and demand.

Second, corporate tax incidence depends on the deductibility of costs from the tax base. If all costs are fully deductible ($\alpha = 1$), the tax is effectively a cash-flow tax which is neutral for factor demand and falls entirely on profits, that is $dP_i = -d\tau_j T_i$ (see Auerbach, 2005, for a detailed discussion of this case). We can summarize these insights 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

[14] In the main text we will focus on a mostly verbal discussion of the different theories. All formal derivations are given in Appendix A.

where either capital or labor costs are less than fully deductible.

2.2 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 natural to expect that part of the loss is shared by employees 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.

2.2.1 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, in which firms and individual employees bargain over a matching rent (see Rogerson et al., 2005, for a survey). If a firm hires a worker who generates a surplus Q and receives a wage w the available surplus after corporate taxes is given by $Q(1-\tau)+\tau(w+\alpha rK)$. A tax increase by $d\tau$ reduces the after-tax surplus before payments to labor and capital by $Qd\tau$ but the tax change reduces the after-tax cost of factor remunerations by $d\tau(w+\alpha rK)$. A higher corporate tax thus reduces the surplus the firm and the employee can share but the tax also "subsidizes" wage payments. Here standard bargaining models like the Nash bargaining model imply that these two effects neutralize each other if and only if all costs are perfectly deductible. In the case of limited deductibility, part of the burden of a higher corporate tax is passed on to employees. This is summarized in:

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.

2.2.2 Collective bargaining

Collective bargaining may take place at the firm-level, the sector-level or at the national level. We consider a model where firms employ workers of different skill levels. Each skill group is represented by a trade union. In the case of firm-level bargaining, we use the efficient bargaining model (McDonald and Solow, 1981), where unions and individual firm owners bargain over wages and employment. We refer to the premium over the reservation wage achieved through bargaining multiplied with the number of workers in a skill group as the rent of the skill group. In the Appendix, we derive the following result:

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 et al., 2012; Fuest et al., 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.

Next, we use the seniority model proposed by Oswald (1993) to analyze collective bargaining at the sector-level.[15] This model assumes that union decisions are dominated by members who are interested in maximizing wages and who are indifferent about the number of employed workers. As a consequence, a sector-level union wants to maximize the sector wide wage rate while the employer representation has the objective to maximize sector wide profits. After wages are determined, firms set the profit maximizing level of employment. In such a setting, we derive the following result:

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.[16]

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[15] The efficient bargaining model used for firm-level bargaining is less suitable for sector-level bargaining because bargaining over employment at the sector-level is difficult and uncommon empirically.

[16] 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.

2.3 Fair wage models

In fair wage models the wage is usually assumed to be a function of i) wages of other employees of the same firm, ii) an external reference wage[17] and iii) profits of the firm (Akerlof and Yellen, 1990). In general, employees of a profitable firm will expect higher wages than those of a less profitable firm (Amiti and Davis, 2010; Egger and Kreickemeier, 2012). If higher corporate taxes reduce after-tax profits, fairness considerations would suggest that employees will bear part of this burden and vice versa. In such a model, we derive the following result:

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

Note that Result 5 is independent of whether or not 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.

2.4 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.[18] In Appendix A, we suggest a model where higher wages increase the expected output of a firm because higher wages lead to better matches between workers and firms (Acemoglu and Shimer, 1999).[19] In this model, we derive the following result:

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

[17] 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.

[18] 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.

[19] 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.

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.

2.5 Monopsonistic labor market

Consider a standard model of a monopsonistic labor market where labor supply to the firm is increasing in the wage rate, and the firm sets wages to maximize profits. In this framework we derive

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.

2.6 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.

2.6.1 Firms operating in multiple jurisdictions with formula apportionment

Consider a firm i with plants in two jurisdictions and assume for the sake of simplicity that there is only one type of labor and that payroll is the only apportionment factor.[20] If a jurisdiction increases its tax rate, the effect on the firm's profit tax rate depends on how the firm's payroll is distributed across jurisdictions. How such a tax change affects wages and employment also depends on the labor market setting and in particular on wage-setting institutions. In the case of firm-level collective bargaining (which is particularly relevant for our empirical analysis), we derive the following result:

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

[20] This is the case for the LBT in Germany. In the US, apportionment for state taxes is based on payroll, sales, and assets, see Suarez Serrato and Zidar (2016). The case for two skill types is discussed in Appendix A. In this case, the wage effect of corporate tax changes is ambiguous since wage changes influence the effective tax rate of the firm, which in turn influences the bargaining process.

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.

2.6.2 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. We extend our model to allow for international income shifting and again focus on the case where wages are set via firm-level bargaining. In this case, income shifting will dilute the effect of corporate tax changes on wages as the tax base becomes smaller. This can be stated as follows:

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.

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.[21] This leads to

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.

2.7 From theory to empirics

In Table 1, we summarize our central theoretical predictions and derive hypotheses that can be tested empirically. In addition to the central theoretical mechanisms, the predicted wage effect, and the empirical implications, the table also provides a preview of the empirical findings, which are extensively discussed in Section 5. Importantly, the empirical tests can only be interpreted as suggestive evidence in favor of or against a theory. For instance, testing whether wage effects of tax changes imply that labor markets are perfectly competitive with mobility of production factors requires a null hypothesis that the wage effect is *different* from zero. Moreover, there might be other reasons why wage effects are zero even if markets are not perfectly competitive (e.g. due to international profit

[21] As we explain in the appendix, income shifting between profits and wages may occur in the form of manipulating wages paid to family members of the owner employed by the firm. These wage payments are not determined via bargaining; rather they are effectively hidden profit distributions.

shifting). As a consequence the testable predictions do not allow us to cleanly separate all theories. However, the rich firm-level data allows us to test various hypotheses from different perspectives, so that we can shed light on the relevance of the different theories for understanding the forces driving corporate tax incidence.

As mentioned before, it is difficult to test for perfectly competitive labor markets, which predict no wage response to corporate tax changes. However, we directly observe whether other wage-setting institutions apply for certain firms. For instance, we know whether wages are a result of collective bargaining. The theory of collective bargaining does not generate unambiguous predictions for how tax changes affect wages. Overall, we find negative wage effects for firms under collective bargaining. Our empirical findings strongly support the theoretical prediction that the incidence effects for firm-level bargaining should be stronger than for sector-level bargaining.

However, we also find small negative effects for firms without collective bargaining. This suggests that other wage-setting mechanisms also play a role. We do not find evidence in favor of monopolistic labor markets as the effect is not increasing in the regional market share of the firm – in fact we find the opposite. In contrast, our empirical findings suggest that fair wage considerations are relevant. First, we find that the negative wage effect is larger for more profitable firms, which is in line with a fair wage model and is suggestive of implicit profit sharing. Second, we can make use of information on whether workers explicitly receive a share of profits as part of their wage. We find negative wage effects for these firms even if the profitability is low.

In the lower part of Table 1, we summarize the theoretical predictions and derivable hypotheses for the specific institutions related to (local) corporate taxation. The effect of the deductibility of capital costs is not testable as capital costs are always less than fully deductible in Germany.[22] However, we can provide a tentative test of a Tiebout effect, which would imply that higher business taxes increase local public goods. This in turn could induce residents to accept lower wages. Including (future) public spending in the empirical model should shut down this channel and hence drive the negative wage effect towards zero. We do not find evidence in favor of this mechanism. In addition, Tiebout effects would suggest that higher local taxes reduce wages even in tax exempt firms, which is also rejected by the data.

[22] Note that, in the case of the German LBT, even the cost of debt financing is not fully deductible.

Table 1: The effects of a local corporate tax under different labor market models

	Model / mechanism	Main assumptions and channel	Predicted wage effect	Testable implications	Empirical findings
1	Competitive LM	Perfect labor mobility	No effect	T1: No wage effect in liable firms without CBA	–
2	Individual Bargaining	Wage as a rent splitting device	Wage declines	T2: Negative effect in liable firms without CBA	(✓)
3	Collective bargaining at firm level	Direct effect on rent accruing to workers, and indirect effect due to employment adjustment	Overall effect ambiguous, direct effect is negative	T3: Negative wage effect (conditional on production factors) for plants with firm-level CBA	✓
4	Collective bargaining at sector level	Overall wage effect due to direct and indirect effect. Size of effect depends on size of sector.	Overall effect ambiguous. Wage effect converges to zero if sector is large and covers many jurisdictions	T4a: Negative wage effect (conditional on production factors) for plants with sector-level CBA T4b: Smaller wage effect for plants with sector-level CBA compared to plants with firm-level CBA	✓ ✓
5	Efficiency wages or directed search models	Higher wages increase productivity	Wage declines	T5: Same as T2	(✓)
6	Fair wage models	Wage also depends on factors such as profits, regional or sectoral wages	Wage declines	T6a: Stronger wage decline in more profitable firms T6b: Wages in non-liable firms should decline	✓ –
7	Monopsonistic LM	Upward sloping labor supply	Wage declines	T7: Effect stronger in firms with higher regional LM power	–
8	Deductibility of capital costs	If costs are fully deductible, cash-flow tax leads to no distortions	Wage effect converges to zero in most theories	Not testable as not all capital costs are deductible	∅
9	Taxes finance public good	Increase of public good quality as compensating differential	Wage declines independent of labor market model	T9: Wage effects should be smaller conditional on future municipal expenses	–
10	Multi-plant firms	Formula apportionment based on payroll	Wage effect smaller if employment share is small relative to total firm	T10: Smaller effect for multi-establishment firms	✓
11	International income shifting	Firms may shift profits abroad	Wage effects become smaller	T11a: Smaller effect for foreign owned firms T11b: Same as T10	✓ ✓
12	National income shifting	Firms may shift profits to labor income tax base	Wage effects smaller in firms with larger share of family workers	T13: Smaller effect in smaller firms	–

In contrast, we find considerable evidence suggesting that formula apportionment and profit shifting play a role for corporate tax incidence. We test the hypothesis that the wage effect in multi-plant firms should be smaller due to formula apportionment by distinguishing between single and multi-plant firms. The results confirm the prediction of the theory. Moreover, result 9 implies that negative wage effects should be smaller in multinational firms, where the tax impact is diluted by profit shifting to other jurisdictions. Indeed we do not find any wage effects for firms with a foreign owner. However, we do not find support for the theory that firms will avoid taxation by shifting profits to the personal income tax base. This should be relevant in small firms, where family members are employed and profits can take the form of higher wages.

3 Institutional background

We test the implications of our theoretical analysis exploiting the particular features of the German corporate tax system. In Section 3.1, we briefly sketch the German business tax system, with special emphasis on the local business tax (LBT, *Gewerbesteuer*).[23] This tax creates quasi-experimental variation in tax rates and is used for identification in the empirical part of the paper. The key features of the nationwide corporate and personal income taxes, the other two profit taxes in Germany, are described in Appendix B. In Section 3.2, we document the cross-sectional and time variation of the LBT. Subsection 3.3 briefly discusses labor market institutions in Germany.

3.1 Business taxation in Germany

In 2007, profit taxes accounted for about 6.2% of total tax revenue (including social security) in Germany (OECD, 2015). This is below the OECD average of about 10.6% (US: 10.8%, UK: 9.4%).[24] There are three taxes on business profits in Germany, the LBT, which is set by municipalities, the corporate tax (CT, *Körperschaftsteuer*) and the personal income tax (PIT, *Einkommensteuer*), the latter two being set by the federal government. Corporate firms are liable to the LBT and the CT, while non-corporate firms are liable to the LBT and the PIT. 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. The share of profit tax revenues from local taxes is relatively high in Germany compared

[23] See Büttner (2003); Janeba and Osterloh (2013); Foremny and Riedel (2014) for studies analyzing the LBT.

[24] Part of this relatively low share is due to the high importance of social security contribution (SIC) in Germany which is among the highest in the OECD. 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 income tax, next to the local business tax, and the OECD does not classify income taxes as profit taxes.

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.

The LBT applies to both corporate and non-corporate firms, while most firms in the agricultural and public sector are not liable. Moreover, certain professions such as journalists, physicians or lawyers are exempt.[25] The tax base of the LBT is similar to that of the corporate income tax.[26] Taxable profits of firms with establishments in more than one municipality are divided between municipalities according to formula apportionment based on the payroll share.

The tax rate of the LBT, τ_{LBT}, consists of two components: the basic federal rate (*Steuermesszahl*), t^{fed}_{LBT}, which is set at the national level, and a local scaling factor (*Hebesatz*), θ^{mun}_{LBT}, which is set at the municipal level. The total LBT rate is given by $\tau_{LBT} = t^{fed}_{LBT} \times \theta^{mun}_{LBT}$. From 1993 to 2007, t^{fed}_{LBT} was at 5.0% and decreased to 3.5% in 2008. The average municipal scaling factor over our sample period (1993 – 2012) was 3.28, yielding an average total LBT rate of 15.2%. In the empirical analysis, we rely on this total LBT rate. The variation of this tax rate is driven by changing local scaling factors (see next subsection). The local scaling factors for year t are set by the municipal councils during the budgeting process of year $t - 1$. Each year the city council has a vote about next year's tax rate – even if it remains unchanged. It is important to note that a municipality can adjust only the scaling factor, that is the tax rate that applies to all firms in the municipality. The local government cannot change the profit tax base or liability criteria, which are set at the federal level.

3.2 Variation in local business tax rates

We use administrative statistics provided by the Statistical Offices of the 16 German federal states (*Statistische Landesämter*) on the fiscal situation of all municipalities. We combine and harmonize the annual state-specific datasets and construct a panel on the universe of all municipalities from 1993 to 2012, covering 228,820 municipality-years. Most importantly, the dataset contains information on the local tax rates, but also on the population size and municipal expenses and revenues.[27]

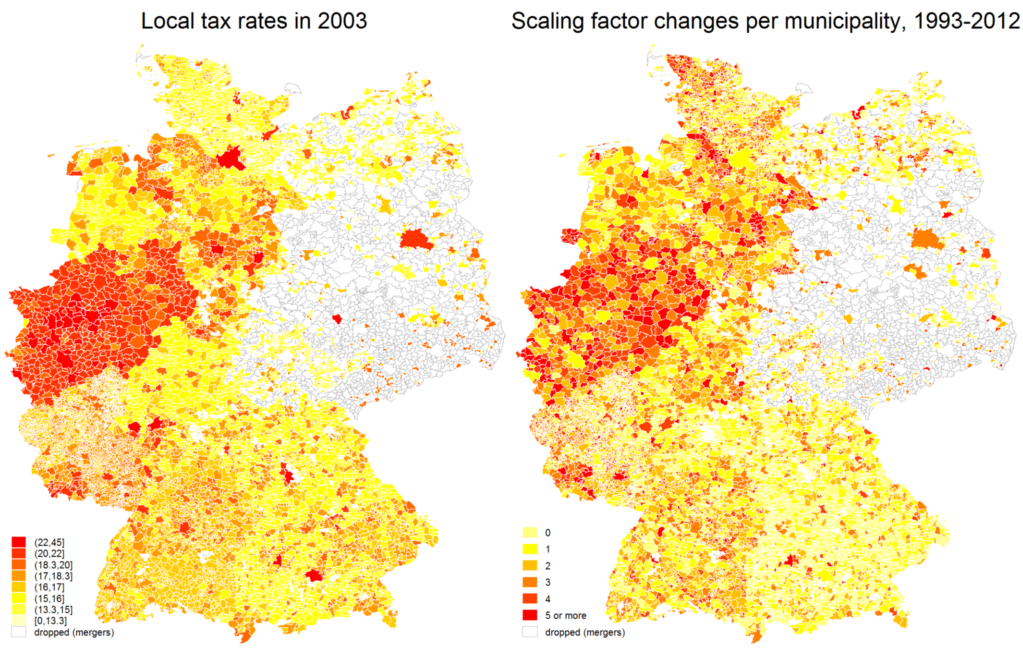
[25]To be precise, §2 and §3 of the *Gewerbesteuergesetz* regulate which firms are exempt from the LBT. The main criteria are interactions of legal form and industry.

[26] The most important difference is that interest payments are only partly deductible. Another difference is that the LBT itself was a deductible expense until 2007.

[27] We also add data from the German federal employment agency on regional unemployment rates on the more aggregate county (*Kreis*) level to control for local labor market conditions.

Figure 1 depicts Germany's 11,441 municipalities (according to 2010 boundaries) and visualizes the substantial cross-sectional and time variation in LBT rates. Table C.1 in the appendix provides measures of the distribution of the scaling factors determining the tax rates annually from 1993 to 2012. For the entire period, the average scaling factor is 3.3, while factors typically vary between 2.8 (P5) and 4.0 (P95). The left panel of the figure shows how the cross-sectional variation in scaling factors translates into differences in local business tax rates for the year 2003, the mid-year of our sample, with darker colors showing higher tax rates. The figure shows 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. We account for such state differences by including state times year fixed effects in our empirical analysis below.

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



Source: Statistical Offices of the Länder. *Notes:* This figure shows the cross-sectional and time variation in municipal scaling factors of the German LBT. 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. The non-filled areas are municipalities that underwent a change of boundaries due to a merger. Those municipalities 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.

The geographical information in the administrative wage data (described in Section 4.2) is provided for the municipal boundaries as of 2010. Due to mergers, some municipal borders changed prior to 2010. As a consequence, we cannot assign the exact business tax rate for affected jurisdictions, as we do not obverse the pre-2010 municipal ID. For this reason, we exclude 47% of East German municipalities[28] and 0.6% of West German municipalities that underwent a municipal merger from our baseline sample (dropped municipalities are depicted in white in Figure 1). The remaining sample consists of about 10,000 municipalities.[29]

We exploit the within-municipality variation in local tax rates over time to identify the business tax incidence on wages. The right panel of Figure 1 demonstrates this variation by showing the number of changes in tax rates per municipality during the period 1993–2012 (with darker colors indicating more changes). Table C.2 in the Appendix shows the corresponding numbers. Overall, only 15% of the municipalities did not change the tax rate during the 20-year period. More than half of the jurisdictions have changed tax rates once or twice, and roughly 15% experienced 4 or more changes. In total we exploit 18,000 tax rate changes for identification. Table C.3 shows that 94% of the changes are increases.[30] Evaluated at the average local tax rate of 15.2%, the average increase implies a change of the local business tax rate by 7% (or 1.1 percentage points). Hence, we are able to exploit many fairly large tax reforms for identification.[31]

3.3 German labor market institutions

As our theoretical predictions depend on underlying wage-setting institutions, we briefly describe the German labor market.[32] Traditionally, German labor unions have been very influential. 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 et al., 2012).[33] In addition to

[28] East German municipalities were rather small after reunification in 1990 and were subsequently merged (sometimes even several times) to bigger jurisdictions.

[29] As a sensitivity check, we impute tax rates for merged municipalities by using weighted averages and check whether results are robust. See Appendix C for a more detailed discussion of the jurisdictional changes and a similar graph with imputed tax rates for all German municipalities (Figure C.1).

[30] In light of the vast international evidence of decreasing tax rates for companies, this seems initially surprising. Yet, both the CT rate and the top PIT rate decreased over the period 1993–2012 so that the overall tax rate for companies decreased as well (see Appendix B for more details). Thus, a rise in the LBT rates in a municipality over time has to be seen as a *slower decrease* in overall tax burdens for firms in these municipalities than with those of firms in other jurisdictions with stable local tax rates.

[31] Suarez 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%).

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

[33] 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

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. Note that 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.

4 Empirical strategies and data

4.1 Empirical models and identification

We implement an event study design to estimate the effect of changes in the local business tax rate on wages. Our baseline outcome variable is the log median real wage in firm f, located in municipality m, which is part of commuting zone (CZ) c and state s, and year t, $w^{p50}_{f(m,c,s),t}$.[34] In order to ease notation, we only include the index of the lowest geographical level for each variable in the following. Formally, our event study model reads:

$$\ln w^{p50}_{f,t} = \sum_{j=-4}^{5} \gamma_j D^j_{m,t} + \mu_f + \mu_m + \psi_{s,t} + \varepsilon_{f,t}, \tag{2}$$

The independent variables of interest are a set of ten event variables $D^j_{m,t}$, which run from 4 years prior to a tax reform to 5 years after. A pre-treatment period of 4 years seems long enough to detect potential pre-trends, while 5 years after treatment suffice to look beyond the short-run effects of the reforms.[35] In addition, we include firm, (μ_f), and municipal, (μ_m), fixed effects.[36] To account for regional shocks, our baseline specification includes "state × year" fixed effects ($\psi_{s,t}$). The error term is denoted by $\varepsilon_{f,t}$.

In the conventional event study model, event variables $D^j_{m,t}$ are dummies indicating a policy reform, $t-j,\ j=-4,...,5$ periods away. In our case, events are tax rate changes, which differ in sizes and signs. The dummy variable specification ignores this information and implicitly estimates the effects of the average change. We can use the information

the UK and some Eastern European countries – but higher than in the US (Du Caju et al., 2008).

[34]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 4.2).

[35] We experimented with different leads and lags, but results are robust to the event window definition.

[36] Note that firm and municipal fixed effects are highly collinear as only very few firms move between municipalities in the data.

about sign and size of the tax change to scale the event dummies (Sandler and Sandler, 2014). In our baseline specification, we define event study variables $D^j_{m,t}$ as follows:[37]

$$D^j_{m,t} = \begin{cases} \sum_{k=-4}^{2012-t} T_{m,t-k} \cdot \Delta\tau_{m,t-k} & \text{if } j = -4 \\ T_{m,t-j} \cdot \Delta\tau_{m,t-j} & \text{if } -4 < j < 5 \\ \sum_{k=5}^{t-1993} T_{m,t-k} \cdot \Delta\tau_{m,t-k} & \text{if } j = 5 \end{cases} \tag{3}$$

where $\Delta\tau_{m,t-j}$ measures the change in the tax rate in municipality m from year $t-j-1$ to year $t-j$ while $T_{m,t-j}$ is a dummy variable equal to one if $\Delta\tau_{m,t-j} \neq 0$. Note that in the conventional model, event dummies are defined as $D^j_{m,t} = T_{m,t-j}$.[38] By scaling the reform dummies with the change in the tax rate, the regression coefficient γ_j indicates by how many percent wages change due to a one percentage point increase in the LBT, they are thus readily interpretable as semi-elasticities. As a robustness check, we also estimate a standard event study, where event variables are defined as dummy variables for tax increases, large tax increases (larger than various percentiles of the tax increase distribution, see Simon, 2016) or tax decreases. Independent of the event coefficient definition, the set of 10 event dummies is perfectly collinear. We drop the regressor for the pre-reform year ($j = -1$) such that all coefficients have to be interpreted relative to the pre-reform year.

In addition to scaling the event dummies, we need to bin up event dummies at the endpoints of the event window (i.e. $j = -4$ and $j = 5$). Hence the dummy $D^5_{m,t}$ ($D^{-4}_{m,t}$) accounts for all reforms happening five or more years ago (in 4 or more years). This binning up is standard practice (see McCrary, 2007) and necessary because we have a balanced panel of time periods (1993-2012) but reform years differ across municipalities, which yields an unbalanced panel in event time.[39] By binning up, we take into account all future and past reforms outside of the event window but inside the sample.

Identification Given that the model includes firm, municipal and time fixed effects, identification is achieved within firms and municipalities over time. We thus estimate a

[37] In Appendix E, we derive the event variable definition given in equation (3) step-by-step starting from a standard event study set-up with one dichotomous reform per panel unit.

[38] The notation in definition (3) is redundant. If there is no change in the tax rate from year $t-j-1$ to year $t-j$, hence $\Delta\tau_{m,t-j} = 0$, the reform dummy $T_{m,t-j}$ will also be equal to zero by definition. Likewise, if reform dummies are switched on, the change in the tax rate will be different from zero. Hence, reform dummies $T_{m,t-j}$ are obsolete. We choose to keep them in the definition to demonstrate the link to the classic event study design without scaling the dummies.

[39] Given wage data from 1998 to 2008 (see Section 4.2), an event window running from 4 years prior to five years after the reform implies that we need tax data from 1993 until 2012, see also Section 3.2.

variant of a DiD model with fixed effects, which requires common trends pre-treatment – that is, no statistically significant wage responses preceding a tax reform – for identification of a causal effect. Given flat pre-trends, our research design would still be invalid if local shocks systematically affected tax rates and wages. We provide two checks to assess whether such potential local shocks are likely to bias our estimates. First, we run event study designs as specified in equation (2) using municipal unemployment, county GDP and municipal fiscal surplus 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 5.1, there are no local shocks to the business cycle prior to a tax change. Second, we further test the sensitivity of the empirical model given in equation (2) with respect to local shocks. Our preferred specification includes "state × year" fixed effects, which non-parametrically account for local shocks at the state level. To test the sensitivity of our model with respect to omitted local confounders, we can control for shocks at different geographical levels. We estimate a simpler model using only year fixed effects and a more complex model with "commuting zone × 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 by "CZ × year" fixed effects. Besides these purely non-parametric specifications, we also estimate a model where we directly account for local time-varying confounders by adding (lagged) county GDP, unemployment and municipal revenues to equation (2). As will be shown below, our results are remarkably robust to this set of tests for omitted confounders.

Differences-in-differences and measuring the tax incidence. The event study described by equation (2) is a variant of a DiD model that informs about (i) potential pre-trends, which is crucial for identification, and, (ii) the dynamics of the treatment effect. Conditional on flat pre-trends a standard DiD model yields the average treatment effect, i.e. the average of the post-treatment event study coefficients, $\gamma_j,\ j = 0, ..., 5$, relative to the pre-treatment coefficients, $\gamma_j,\ j = -4, ..., -1$. Given that municipalities change tax rates frequently, which makes it difficult to identify long-term effect, the average effect seems to be the most relevant policy parameter in our context. We estimate the following generalized DiD model

$$\ln w^{p50}_{f,t} = \delta \tau_{m,t} + \mu_f + \mu_m + \psi_{s,t} + \varepsilon_{f,t}, \tag{4}$$

by regressing the median wage of firm f in year t on the tax rate in municipality m at time t, conditional on firm, municipality and "state × year" fixed effects.

The estimate of $\hat{\delta}$ is a semi-elasticity, measuring the percent change in wages induced by a one percentage point increase in the local business tax rate, $\hat{\delta} = \frac{dw}{d\tau}\frac{1}{w}$. We can use

$\hat{\delta}$ to calculate the incidence of the corporate tax on wages, which describes the wage bill response to a marginal change in the tax bill, $\frac{d(wL)}{d(\tau T)}$, in euros, where T is the tax base (Arulampalam et al., 2012). Hence, we translate the wage elasticity into a money metric. For given production factors, it follows that $dT = -Ldw$. It is then straightforward to show that the incidence measure is given by

$$\frac{d(wL)}{d(\tau T)} = \frac{Ldw}{Td\tau + \tau dT} = \frac{Ldw}{Td\tau - \tau Ldw} = \frac{1}{\frac{T}{\hat{\delta}wL} - \tau}. \tag{5}$$

Note that the burden of corporate taxes for the economy as a whole is typically higher than the tax revenue raised, due to the excess burden of corporate taxation caused by investment distortions. Denote the marginal excess burden for the economy as a whole by MEB. If we want to express the burden borne by workers through lower wages as a share of the burden of raising an additional unit of corporate tax revenue for the economy as a whole, we can do so using the formula $\frac{d(wL)}{d(\tau T)} \cdot \frac{1}{(1+MEB)}$. In addition to the estimated semi-elasticities, we report both incidence measures below. The value for τ is taken from our data, the fraction $\frac{T}{wL}$ is calculated using official tax and labor statistics (see Appendix Table D.4 for details) and the marginal costs of public funds are set to $MEB = 0.3$ as used in the literature (Feldstein, 1999; Busso et al., 2013; Devereux et al., 2014).

Municipal level estimations. We also estimate event study and DiD models at the municipal level, given that the identifying variation is at this level. The respective models are defined as follows:

$$\ln w_{m,t} = \sum_{j=-4}^{5} \gamma_j D^j_{m,t} + \mu_m + \psi_{s,t} + \varepsilon_{m,t}, \tag{6}$$

$$\ln w_{m,t} = \delta \tau_{m,t} + \mu_m + \psi_{s,t} + \varepsilon_{m,t}, \tag{7}$$

Here, the outcome is the log median wage in municipality m.

Individual level estimations. Moreover, we run regressions at the worker level, implementing the following models:

$$\ln w_{i,t} = \sum_{j=-4}^{5} \gamma_j D^j_{m,t} + \mu_i + \mu_f + \mu_m + \psi_{s,t} + \varepsilon_{i,t}, \tag{8}$$

$$\ln w_{i,t} = \delta \tau_{m,t} + \mu_i + \mu_f + \mu_m + \psi_{s,t} + \varepsilon_{i,t}, \tag{9}$$

The outcome variable is now the log wage of individual i, working in firm f that is situated in municipality m. Again we add "state $\times$ year" fixed effects and we also add individual fixed effects to the models, so identification is within individual-firm-municipality cells.

Heterogeneous effects. In order to test for heterogeneous worker and firm effects, we interact the local tax rates in the DiD models with firm or worker characteristics. Note that some of those characteristics such as collective bargaining agreement or single vs. multi-establishment firm are potentially endogenous and may respond to the tax rate. For this reason, we fix the characteristics to the values of 1997, i.e., the year prior to our first panel observation. Heterogeneous firm effects are estimated at the firm level, and worker effects on the individual level.

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 et al., 2004), we conduct two tests to assess the sensitivity of our estimates (see Appendix D): 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. Standard errors of estimates are hardly affected.

4.2 Linked employer-employee data

We combine the administrative municipal data presented in Section 3.2 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 et al., 2005).

The firm component of the LIAB is the IAB Establishment Panel (Kölling, 2000), which is a stratified random sample of all German establishments. The term establishment refers to the fact that the observational unit is the individual plant, not the firm. The employer data covers establishments with at least one worker subject to social insurance contributions. The sample covers about 15,000 establishments, which corresponds to about 1% of all German establishments. We extract the following variables: value added, investment, number of employees, industry, total wage bill, legal form, union wage status (industry, firm or no collective agreement) and self-rated profitability.[40]

[40] The survey question asks for a self-assessment of the profit situation on a five-point scale ranging from very good to unsatisfactory. We pool the two answers "very good" and "good" as well as "fair" and "poor" and construct a three-point scale (high, medium, low) for profitability with well-balanced support over the three categories.

In addition to the plant-level information, the dataset contains information on all employees in the sampled establishments. 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 et al., 2000).[41] The employee information are recorded on June 30th of each year and include information on wages, age, tenure, occupation, employment type (full-time or part-time employment) and qualification. Individuals with missing information are excluded. Our worker panel consists of between 1.6 and 2.0 million workers (corresponding to about 6% of all workers) annually observed from 1998 to 2008. The choice of years is driven by data availability for the tax rate data to allow for a sufficient number of years before and after the tax reforms. Furthermore, ending in 2008 avoids the effects of the Great Recession.

Importantly, wages are right-censored at the ceiling for social security contributions. Although the ceiling is quite high, with annual labor earnings of 63,400 euros in 2008 for Western Germany, up to 13% of the observations are censored (see Appendix Table C.6 for the distribution of censored workers across firms). Note that the censoring does not affect results on 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 underestimate of the wage effect. As a sensitivity check, we exclude all individuals who at least once earned a wage above the contribution ceiling during the observation period.[42] As shown below, this exclusion affects the results for high-skilled workers.[43]

Descriptive statistics. Appendix Tables C.4, and C.5 present descriptive statistics of our plant and worker level sample in non-merged municipalities.[44] Table C.4 shows that the average median firm wage is 2,723 euros. The average local scaling factor is 3.76. The average (median) plant has 273 (57) employees. 64% of the plants are liable to the LBT. 61% of the establishments are single-plant firms. More than half of the firms have sector-level bargaining agreements in place, while only a third has no CBA. Not surprisingly,

[41] Note that civil servants, self-employed individuals and students are not observed in the social security data. The data nonetheless contain more than 80% of all employed persons in Germany.

[42] As a further robustness check, we estimated quantile fixed effects models to test for different effects across the wage distribution, finding no substantial differences. Imputing censored wages is another option used in the literature (Dustmann et al., 2009; Card et al., 2013). While this is sensible when analyzing wage inequality, it is problematic in our study. In fact, the LBT rate would have to be a regressor in both the Tobit model and the even study design.

[43] 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.

[44] In the baseline, we only consider full-time workers. We also looked at the effects on part-time wages but find no significant differences, see the discussion in Section 5.3.

we observe more workers in larger firms. As larger firms pay higher wages, we see that the median wage in the individual level sample increases to 3,375 euros per month (see Table C.5). The average (median) number of workers increases to 5,665 (1,148). In terms of individual characteristics, the table shows that the average worker in our sample is 41 years old. The share of males is 73%. 14% of the individuals are high skilled, while about as many are low skilled. 81% of the individuals have never earned a wage higher than the social security contribution ceiling in our sample.

5 Empirical results

In this section, we estimate the incidence of corporate taxation on wages. Before turning to our main results, we test our identifying assumption by analyzing whether local productivity shocks affect tax rate changes.

5.1 Drivers of local tax rate changes

While it is common to use variation in policies across regions and over time to identify policy effects, the approach requires exogenous policy changes with respect to the outcome variables. A particular concern in our setting is whether tax rates respond to local business cycle shocks, which could also affect wages.[45] Analyzing pre-trends in our event study design provides a first test of the identifying assumption. As will be shown below, wage rates do not change significantly prior to tax changes. In addition, we can test directly for violations of the identifying assumptions by using local economic outcomes as left-hand-side variables in the event study model. In particular, we test whether unemployment, GDP and fiscal surplus change prior to tax reforms.

Panel A of Appendix Figure D.3 shows that municipal unemployment levels are flat prior to a tax reform. Similarly, Panel B shows no significant pre-trends for GDP.[46] While we find no evidence of significant pre-trends, we do find that county GDP (unemployment) decreases (increases) after the reform.[47] Finally, in Panel C, we show the evolution of fiscal surpluses per capita, defined as revenues minus expenses, before and after a tax change. While pre-trends are again remarkably flat, we find an increase in the fiscal surplus in the year of the tax increase. It seems that this fiscal surplus will be "eaten up" in years 1 to 3 after a tax increase. While the effect is quite small, we nevertheless include local

[45] Previous evidence for the German LBT (Foremny and Riedel, 2014) as well as for income tax reforms in Europe (Castanheira et al., 2012) suggest that tax changes are typically triggered by political concerns, not economic variables.

[46] Note that local GDP data are available at the county level but not at the municipal level.

[47] In a companion paper, Siegloch (2013) further investigates the (un)employment effects of the LBT.

expenditures in some specifications to test the robustness of our results when accounting for potentially improved public services in a municipality with increasing local tax rates.

5.2 Baseline results

In this section, we present our main results on the business tax incidence on wages. We start by presenting results graphically plotting the $\hat{\gamma}$ coefficients (multiplied by 100 depicting percent changes in wages) and the corresponding 95% confidence intervals of our event study design as given in equation (2) in Figure 2.[48] The estimates can thus be interpreted as the semi-elasticity of the wage rate with respect to the LBT rate. As discussed in Section 3.2, we focus on the 10,000 municipalities that did not change jurisdictional borders between 1993 and 2012. Looking at all firms in these non-merged municipalities, Figure 2 shows a significantly negative effect in the post-treatment periods, while pre-reform trends are flat and not statistically different from zero (blue line). After a change in the LBT rate in period 0 (indicated by the vertical red line) real wages start to decline.[49] After five years, we find that a one percentage point increase of the LBT leads to a wage decrease of 0.4%. In order to derive the average post-treatment effect relative to the pre-treatment period, we estimate DiD models as given by equation (4). We regard this average effect as the most meaningful estimate in our context, as the long-run effect might not materialize given the frequent tax changes of municipalities. The corresponding semi-elasticity of the DiD model is −0.220 (see Table 2). Applying formula (5), we transform this estimate into a money metric. We find that a 1-euro increase in the tax bill, leads to a decrease in the wage bill of 29 cents. If we take into account the marginal cost of public funds, which we assume to be 0.3, our headline measure of the business tax incidence on wages is $\frac{-0.291}{1+0.3} = -0.224$ (see Appendix Table D.4).

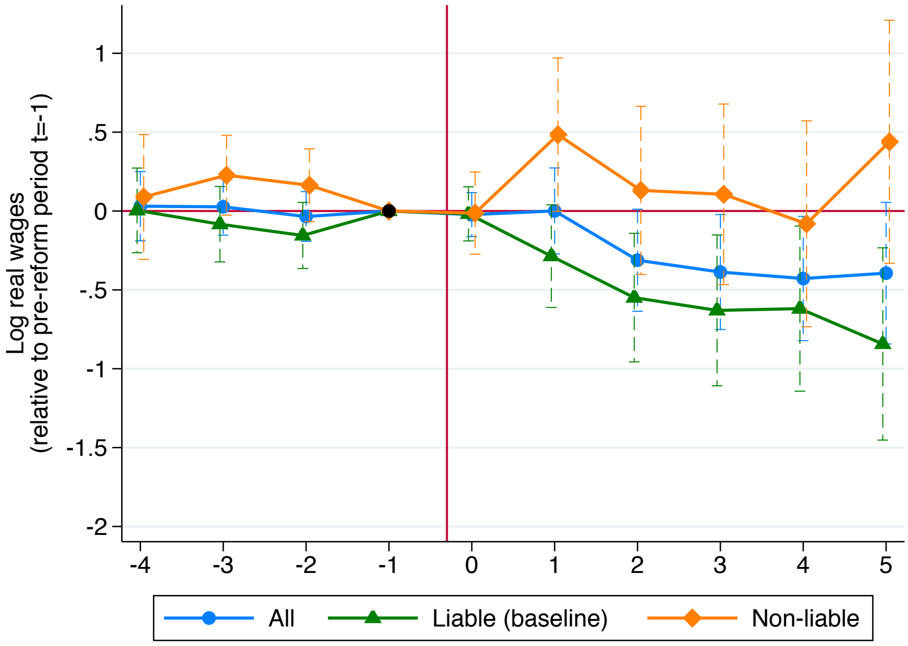
Next, we differentiate between firms that are liable to the LBT and firms that are exempt. We find that only wages in liable firms respond negatively to tax increases with a semi-elasticity of the wage rate of −0.8% five years after a tax change.[50] The corresponding DiD estimate is −0.487, which yields an incidence measure of −0.466 (cf. Table 2). For

[48] Regression estimates are provided in Appendix Table D.1.

[49] Note that we do not observe a fall in nominal wages in our data but a slower growth of wages in affected firms over time leading also to lower levels in the future.

[50] In order to demonstrate that results are not driven by scaling the event dummies by the size of the tax change, we also estimate event study specifications using dummy variables indicating tax increases (following Simon, 2016, we look at all as well as the 50%, 25% and 10% largest increases as well as tax decreases). Results are presented in Appendix Figure D.1. Point estimates for all specifications are negative but usually only statistically significant for the 10% or 25% largest increases. Reassuringly, when multiplying the estimated coefficients with the average tax increase, the resulting wage elasticities are similar to those obtained from our baseline specification (as expected from the discussion in Section 4 and Appendix E).

Figure 2: Effects on firm wages – by liability to local business tax



Source: LIAB and Statistical Offices of the Länder. *Notes:* All curves depict event study estimates ($100 \times \hat{\gamma}_j, j \in [-4, 5]$) and the corresponding 95% confidence bands obtained by estimating equation (2), using event variable definition (3). Transformed coefficients measure the semi-elasticity of the wage with respect to a one percentage point increase in the LBT. The tax change occurred for the treatment group on 1 January in event year $t = 0$, as indicated by the vertical red line. Wages are observed on 30 June for each year. All regression models include municipal, firm and "state × year" fixed effects. The estimation sample comprises all establishments in non-merged municipalities. Treatment effects are estimated for all plants, as well as separately for liable and non-liable plants (see legend). Standard errors are clustered at the municipal level. Full regression results are shown in Appendix Table D.1.

non-liable firms, point estimates are positive and statistically not significant. If non-liable firms were not affected at all by the tax increase, we could estimate a triple-difference model and the difference between the two curves would be the treatment effect. This would increase the negative wage effect. However, on the one hand, exempted firms might benefit from changes in public goods financed through higher taxes or might be affected by, for instance, fair wage considerations within the region. These mechanisms would lead to a negative wage effect for non-liable firms as well. On the other hand, a higher tax might give tax-exempt firms a comparative advantage, which could lead to positive wage effects. In any case, we cannot be sure that they are a valid control group. For these reasons, we refrain from overemphasizing the triple-difference estimates. We rather consider the results for liable firms as our baseline estimates and exclude non-liable firms from the sample for any further analyses.

Our baseline models are estimated at the firm level. We can equally estimate event study designs at the municipal and individual level, according to equations (6) and (8), respectively. Appendix Figure D.2 presents the results. While estimates are a bit more

Table 2: Differences-in-differences estimates at firm level: baseline results

	(1) all firms	(2) liable	(3) non-liable
LBT rate ($\hat{\delta} \times 100$)	-0.220^{*}	-0.487^{***}	0.246
	(0.126)	(0.165)	(0.197)
Euro measure	-0.291^{*}	-0.606^{***}	0.367
	(0.158)	(0.183)	(0.313)
Incidence	-0.224^{*}	-0.466^{***}	0.282
	(0.122)	(0.140)	(0.241)
N	56,443	36,141	20,302

Source: LIAB. *Notes:* This table presents the DiD estimates ($100 \times \hat{\delta}$) of regression model (4). Transformed coefficients measure the semi-elasticity of the wage with respect to a one percentage point increase in the LBT. All specifications include firm and municipal fixed effects, as well as "state × year" fixed effects. The estimation sample comprises establishments in non-merged municipalities. Standard errors are clustered at the municipal level. The euro measure indicates the response in the wage bill to a one euro increase in the tax bill. It is calculated by plugging the semi-elasticities into formula (5). The incidence measure is based on the euro measure, but additionally takes into account the marginal cost of public funds, which is assumed to be 0.3. Standard errors for euro and incidence measures are calculated using the Delta method. Significance levels are $^{*} < 0.10$, $^{**} < 0.05$, $^{***} < 0.01$.

noisy on the municipal level due to smaller numbers of observations and the fact that the wage measures includes liable and non-liable firms, effects are reassuringly similar.[51]

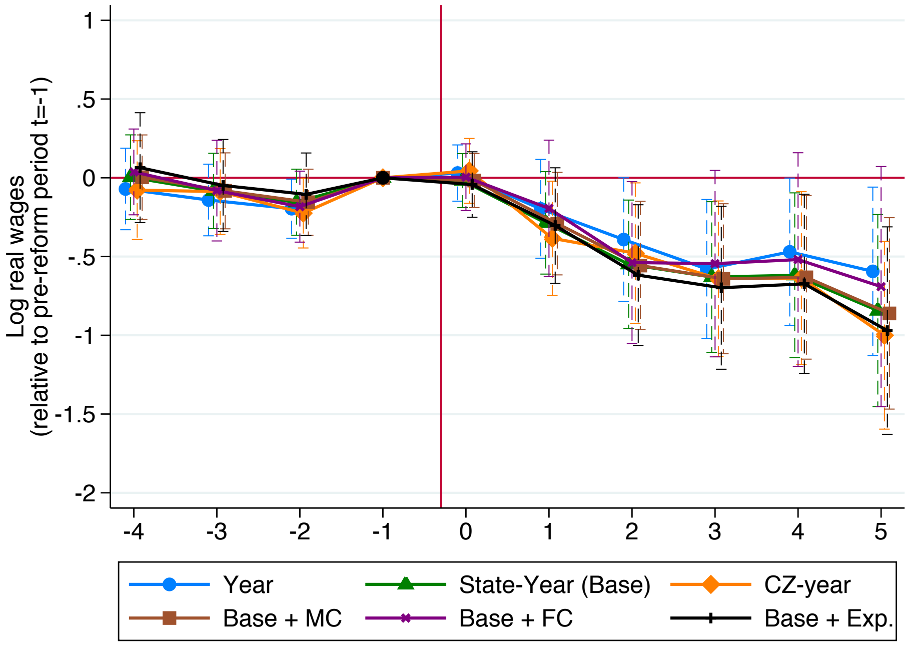
In the next step, we check whether our baseline estimate is robust to unobserved local shocks. Our baseline specifications laid out in equations (2) and (4) include "state × year" fixed effects to non-parametrically account for local shocks. We estimate various specifications in which we vary the set of control variables, replacing "state × year" with simple year fixed effects or more evolved "commuting zone (CZ) × year" and/or adding municipal controls, capturing the local business cycle (log municipal revenues, log municipal population, log county unemployment rate, log county GDP).[52] Table 3 and Figure 3 provide the results for the DiD and event study estimates, respectively. The results are very robust across the different specifications. This suggests that unobserved local shocks do not drive our results. If those shocks were important, estimates should vary across different specifications. If anything, negative wage responses increase if we control for local shocks in a more sophisticated way. This suggests that endogeneity would bias our estimates towards zero.

There are several different channels which might lead to the observed wage effects

[51] Results at the municipal level also take into account firm exit and entry given that the dependent variable is the median wage in the municipality, which should change if the firm composition changes.

[52] All control variables are lagged by two periods to avoid endogeneity issues; results are similar when using contemporaneous variables.

Figure 3: Effects on firm wages – robustness with respect to controls



Source: LIAB and Statistical Offices of the Länder. *Notes:* All curves depict event study estimates ($100 \times \hat{\gamma}_j, j \in [-4, 5]$) and the corresponding 95% confidence bands obtained by estimating equation (2), using event variable definition (3). Transformed coefficients measure the semi-elasticity of the wage with respect to a one percentage point increase in the LBT. The tax change occurred for the treatment group on 1 January in event year $t = 0$, as indicated by the vertical red line. Wages are observed on 30 June for each year. 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 (see legend). Municipal controls (MC) are log municipal revenues, log municipal population, log county unemployment rate, log county GDP (all lagged by two periods). Firm controls (FC) include employment, investment and output. Municipal expenses (Exp.) include contemporaneous municipal spending. The estimation sample comprises all establishments in non-merged municipalities. Standard errors are clustered at the municipal level.

besides the direct wage-setting process. In order to investigate these, we run several sensitivity checks reported in Appendix Table D.2. First, our estimates remain unaffected when adding firm-level control variables such as employment.[53] Second, our results are also robust to including future and current municipal expenses as control variables. Such a specification shuts down one theoretical channel that might lead to a wage response from a tax reform. As discussed in Section 2, higher taxes might lead to higher municipal spending and thus better local public services, which in turn might generate lower wages in the form of a compensating differential. Estimates increase if we control for municipal spending, which speaks against a Tiebout sorting effect being at play. Third, we check whether results are driven by the composition of the workforce. Results are not affected

[53] On the one hand, the differences between the estimates with and without firm controls can be seen as a test of the "direct" vs. the "indirect" wage effects, see Section 2. On the other hand, these control variables are potentially endogenous to taxes (despite being lagged due to, say, serial correlation). Therefore, we refrain from putting too much weight on interpreting the estimates with firm controls.

Table 3: Differences-in-differences estimates at firm level: robustness to local shocks

	(1)	(2)	(3)	(4)	(5)	(6)
LBT rate ($\hat{\delta} \times 100$)	-0.341^{**}	-0.350^{**}	-0.487^{***}	-0.494^{***}	-0.513^{***}	-0.476^{***}
	(0.141)	(0.142)	(0.165)	(0.166)	(0.172)	(0.171)
Year FE	✓	✓				
State × year FE			✓	✓		
CZ × year FE					✓	✓
Municipal controls $t-2$		✓		✓		✓
N	36,141	36,141	36,141	36,141	36,141	36,141

Source: LIAB. *Notes:* This table presents the DiD estimates ($100 \times \hat{\delta}$) of regression model (4). Transformed coefficients measure the semi-elasticity of the wage with respect to a one percentage point increase in the LBT. 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 comprises all establishments liable to the LBT in non-merged municipalities. Standard errors are clustered at the municipal level. Significance levels are $^{*} < 0.10$, $^{**} < 0.05$, $^{***} < 0.01$. Our preferred (baseline) estimates are shown in column (3).

when controlling for various worker shares at the firm level (by age, gender, skill, occupation and employment type). In line with this result, we also find that theses shares themselves are hardly affected by the tax changes.

Finally, given the problem of biased standard errors in DiD models (Bertrand et al., 2004), we show that standard errors hardly change when clustering at higher aggregation levels than the municipality such as county or commuting zone (see Appendix Table D.3).

5.3 Heterogeneous effects

In this subsection, we test for heterogeneous firm and worker effects. By doing this, we try to tease out the underlying mechanisms driving wage responses to tax rate changes and relate these back to our theoretical considerations (see Section 2.7).

Heterogeneous firm effects. Table 4 shows the estimates from the DiD model (2), where we interact the LBT rates with dummy variables for various firm types. First, we test for differences by industry. We find only slightly larger (negative) effect for manufacturing and construction sector firm, compared to the service sector. The resulting incidence measures are 55% for manufacturing and 45% for services (see Appendix Table D.4). The small difference in the incidence effects across the two sectors sheds some light on the role of price effects in our setting given that German manufacturing firms mostly produce highly tradable goods, whereas goods in the service sector are less tradable. Detecting no substantial differences in the overall wage effects indeed suggests that price channel should play a minor role in our local setting.

Next, we take a closer look at the interactions between collective bargaining and business taxation that might drive the different responses by sector. Results 3 and 4 state that wage effects in the presence of collective bargaining are ambiguous in general. On the one hand, the rent that is shared between workers and firms declines if corporate taxes increase. On the other hand, employment might react to tax changes, which can lead to wage increases depending on the substitutability of the production factors. We group firms into three categories: firms with (i) a sector-level collective bargaining agreement (CBA); (ii) a firm-level CBA; (iii) no CBA. Our theoretical model predicts wage effects to be stronger for firm-level bargaining than for sector-level bargaining – especially if the sector has a presence in many municipalities (cf. Result 4). Our estimates confirm this prediction: the incidence measure is 92% for firms with firm-level CBA compared to 47% for sector-level CBA firms (see Appendix Table D.4). Nevertheless, we see a negative (yet insignificant) wage response for firms without collective bargaining as well.

A potential explanation for the negative effect for firms without CBA could be that other labor market institutions are at play. If firms have some wage-setting power as stipulated in the monopsony model, this should yield a negative wage effect as well. We test the relevance of this model by interacting the local tax rate with a dummy indicating whether the size of the firm relative to the local labor market is small or large (i.e. below or above the median). We find that relatively small firms react more strongly, which is evidence against a monopsonistic labor market. Using an alternative measure of firm size (terciles of value added in 1997)[54], we confirm this result: the negative effect is driven by smaller plants, while the largest plants do not react at all.

Fair wage models would also predict negative wage effects of corporate taxes (see Theoretical Result 5). If wages are a function of firm (after-tax) profits, parts of the tax burden should be passed onto workers. Drawing on responses from a question of self-rated profitability, Table 4 shows that more profitable firms indeed see larger wage decreases after tax increases. While this is a rather indirect test of fair wage models, we can make use of additional information in the data on whether firms share profits with workers in the form of higher wages. Splitting the sample into firms that engage in profit sharing and firms that do not, we see that the effects by profitability is different between the two types of firms. While the negative wage semi-elasticity is increasing in the profitability of firms if there is no direct profit sharing measure (i.e. there is indirect profit sharing, for instance via individual bargaining), there is no clear pattern of the wage effect by profitability for firms with direct profit sharing.

[54] We find the same result when we (a) construct the size categories year by year and allow for switching size groups and (b) use number of employees as a measure of firm sizes

Table 4: Differences-in-differences estimates: firm-level heterogeneity, liable firms

Stratified by ...	Effect of LBT rate ($\hat{\delta} \times 100$) by firm type				N
Sector	Manuf.	Const.	Trade	Serv.	36,141
	-0.597^{***}	-0.581^{*}	-0.307	-0.475^{*}	
	(0.207)	(0.344)	(0.490)	(0.286)	
Collect.-Barg. agreem.	Firm	Sector	None		36,141
	-1.100^{**}	-0.495^{***}	-0.392		
	(0.487)	(0.166)	(0.327)		
Size rel. to local labor market	Below P50	Above P50			36,141
(market power)	-0.812^{***}	-0.412^{**}			
	(0.281)	(0.192)			
Firm size	Small	Medium	Large		28,474
	-0.833^{**}	-0.072	0.044		
	(0.334)	(0.206)	(0.245)		
Profitability	High	Medium	Low		35,302
	-0.684^{**}	-0.372	-0.352		
	(0.290)	(0.241)	(0.272)		
Profitability	High	Medium	Low		31,881
... firms w/o profit sharing	-0.683^{**}	-0.342	-0.237		
	(0.299)	(0.239)	(0.280)		
... firms w/ profit sharing	-0.743^{***}	-0.379	-0.545^{*}		
	(0.298)	(0.258)	(0.277)		
Firm structure	Single-plant	Multi-plant			35,796
	-0.589^{***}	-0.187			
	(0.211)	(0.226)			
Ownership	German	Foreign			36,141
	-0.570^{***}	0.483			
	(0.184)	(0.416)			

Source: LIAB. *Notes:* This table presents the DiD estimates ($100 \times \hat{\delta}$) of regression model (4) 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. Transformed coefficients measure the semi-elasticity of the wage with respect to a one percentage point increase in the LBT. 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. Standard errors are clustered at the municipal level. Significance levels are $^{*} < 0.10$, $^{**} < 0.05$, $^{***} < 0.01$.

Next, we turn to interactions of the LBT with other corporate tax institutions. Theoretical Result 8 indicates that the wage effects are ambiguous if firms operate plants in several jurisdictions. In fact, if we assume just one type of labor, wage responses converge towards zero if the share of employment in the taxed jurisdiction over total firm employment declines. In line with the prediction, Table 4 shows negative wage effects only for single-plant firms, while establishments in multi-plant firms show no significant wage response. We test that this effect is not driven by firm size. Hence, our evidence suggests that formula apportionment can dilute the negative effect of taxes on wages.

Theoretical Result 9 states that international income shifting should drive the negative wage effects towards zero. We verify this prediction by showing that there is a zero (to be precise: a very insignificant, positive) wage effect if a plant has a foreign owner. Again, this result is not driven by firm size. Last, we test for national income shifting from the business to the personal income tax base as predicted by Theoretical Result 10. This effect would be particularly relevant in small firms where earnings of family members make up a large share of the wage bill. Since the wage effects in small firms are larger in our data, we can reject this theory.

Heterogeneous worker effects Next, we test for worker heterogeneity by estimating model (8) at the individual level. The results are presented in Table 5. We restrict our estimation sample as above and focus on liable firms in non-merged municipalities. 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 problematic due to the censoring of the wages at the ceiling for social security contributions as discussed in Section 4.2. Theoretically, wage censoring biases our estimates towards zero. If all workers always earned above the contribution ceiling, we would not be able to detect any wage changes in the data. 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.[55] We find that negative wage effects increase when restricting the sample to never censored workers.

In our first test, we look at the effect by skill. While effects are similar for medium and low-skilled workers, we find no negative wage effect for high-skilled individuals. A potential reason for this difference (in addition to wage censoring) is that high-skilled workers are more mobile than low-skilled individuals. In any case, our findings have

[55] On the firm level, our dependent variable is the median wage in the firm, which is not affected by wage censoring. Nevertheless, we conducted robustness checks, which suggest that censoring biases estimates towards zero. First, controlling for the share of censored workers increases the negative wage effect (see column (4) of Appendix Table D.2). Second, we find that wage effects are stronger for firms with fewer censored workers.

Table 5: Differences-in-differences estimates: Worker heterogeneity

Stratified by ...	Effect of LBT rate ($\hat{\delta} \times 100$) by worker type			N
Skill	High	Medium	Low	
All workers	-0.011	-0.431^{***}	-0.454^{*}	7,186,305
	(0.191)	(0.167)	(0.240)	
Not wage-censored	-0.067	-0.485^{**}	-0.497^{*}	5,676,972
	(0.338)	(0.200)	(0.276)	
Age	Young	Medium	Old	
All workers	-0.516^{***}	-0.420^{***}	-0.419^{***}	7,186,305
	(0.179)	(0.159)	(0.155)	
Not wage-censored	-0.556^{***}	-0.437^{**}	-0.460^{**}	5,676,972
	(0.214)	(0.192)	(0.180)	
Occupation	Blue-collar	White-collar		
All workers	-0.439^{**}	-0.388^{**}		7,186,278
	(0.194)	(0.152)		
Not wage-censored	-0.476^{**}	-0.415^{**}		5,676,947
	(0.234)	(0.171)		
Gender	Female	Male		
All workers	-0.769^{***}	-0.385^{**}		7,186,305
	(0.178)	(0.177)		
Not wage-censored	-0.806^{***}	-0.454^{**}		5,676,947
	(0.188)	(0.222)		

Source: LIAB. *Notes:* This table presents the DiD estimates ($100 \times \hat{\delta}$) of regression model (9) for different types of workers as indicated in the table. The heterogeneous effects are estimated by interacting the LBT rate with dummy variables for different worker types. Transformed coefficients measure the semi-elasticity of the wage with respect to a one percentage point increase in the LBT. 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 full-time workers in establishments liable to the LBT in non-merged municipalities. Standard errors are clustered at the municipal level. Significance levels are $^{*} < 0.10$, $^{**} < 0.05$, $^{***} < 0.01$.

important redistributive implications as lower ability workers seem to bear the tax burden.

While we do not find strong evidence for different effects by age or broad occupation group (blue vs. white collar), we do find larger effects for women than for men. We tested whether this effect is driven by industry, full-time vs. part-time workers, or occupations, but the gender differences in the wage semi-elasticity persist.

6 Conclusions

In this paper, we exploit the institutional setting of the German local business tax to analyze the incidence of corporate taxation on wages. We combine administrative information from 1993 to 2012 on the universe of municipalities with administrative linked employer-employee data to estimate the effect of corporate taxation on wages. Averaging over all firms, we find that a 1-euro increase in the corporate tax bill leads to a 0.29-euro decrease in the wage bill. Focusing on firms liable to the LBT, the effect increases to 0.61. This suggests that labor bears about 47% of the total tax burden. This finding is similar to other studies analyzing the corporate tax incidence on wages (Arulampalam et al., 2012; Liu and Altshuler, 2013; Suarez Serrato and Zidar, 2016).

Estimating heterogeneous firm and worker effects, we test the predictions generated by our theoretical framework. First, we do not find any effects on 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 are rents in the labor market, due to collective bargaining for instance, wage responses are larger. Third, wage effects are close to zero for firms which operate in multiple jurisdictions, confirming the theoretical prediction that formula apportionment will dilute the effects of tax changes. Wages effects are also negligible in large firms and foreign owned firms. This may be explained by international profit-shifting opportunities available to these firms.

Our results confirm the view that labor bares a substantial share of the corporate tax burden. At the same time, our results show that the extent of tax shifting differs considerably across firms. Importantly, our results are obtained by exploiting variation at the local level. Corporate taxes levied at the subnational level exist in many countries including the US and Canada. Many of the results derived here are likely to be be relevant in these countries as well. But it is natural to ask whether our results are also relevant for national corporate taxes. Two potential differences between national and subnational corporate tax changes are worth noting. On the one hand, labor is likely to be more mobile at the local level, which attenuates the wage effect. On the other hand, focusing on tax changes at the local level implies that price changes (both of goods and other production factors) 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.

In terms of policy implications, it is important to take into account distributional effects of corporate tax changes. A key result of our analysis is a larger part of the corporate tax is borne by labor if employees capture rents in the labor market. Since these employees are likely to earn higher wages and have more stable jobs, the fact that they bear a larger part of the tax burden compared to more vulnerable worker may be seen as a desirable feature of the corporate income tax. However, our findings also suggest that wages of workers with low and medium skills seem to fall more in response to corporate tax increases points to a regressive effect of corporate taxes.

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Appendices for online publication only

A Theoretical derivations

In this appendix, we discuss the implications of various wage-setting models for the impact of corporate tax changes on wages. We do so by using the model introduced in the main text, which we discuss here in greater detail. 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 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.[56] 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

$$P_{ij} = p_i F_i(K_i, L_i^h, L_i^l)(1 - \tau_j) - \sum_k w_i^k L_i^k (1 - \tau_j) - (1 - \alpha\tau_j) r_i K_i \qquad (10)$$

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. 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. 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 $\overline{w}^k$. In the following we drop the index j for firm variables to ease notation.

A.1 Competitive labor market

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

[56] 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.

first order conditions

$$\frac{\partial F_i(K_i, L_i^h, L_i^l)}{\partial K_i} = \frac{(1-\alpha\tau_i)}{(1-\tau_i)} r \tag{11}$$

and

$$\frac{\partial F_i(K_i, L_i^h, L_i^l)}{\partial L_i^k} = w_i^k. \quad k = h, l. \tag{12}$$

Equations (11) and (12) 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 $W_i^k = w_i^k$, $k = h, l$ and $R_i = r\frac{1-\alpha\tau_i}{1-\tau_i}$ is the tax inclusive cost of labor of type k and capital, respectively. 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, where the latter is given by the function $L_i^{kS}(w^k), k = h, l$. 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 for example the effect on wages of skill type h:

$$\begin{aligned} \frac{dw_i^h}{d\tau_i} = & \frac{L_i^{hD} L_i^{lD}}{\varphi} \left((\varepsilon_{lR} \frac{1-\alpha}{(1-\alpha)(1-\alpha\tau_i)} \right) \left(\varepsilon_{hh} \frac{1}{w_i^h} \right) \\ & - \frac{L_i^{hD} L_i^{lD}}{\varphi} \left((\varepsilon_{hR} \frac{1-\alpha}{(1-\alpha)(1-\alpha\tau_i)} \right) \left((\varepsilon_{ll} - \mu_l) \frac{1}{w_i^h} \right) \end{aligned} \tag{13}$$

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 (13) 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.

A.2 Corporate tax incidence with wage bargaining

A.2.1 Individual wage bargaining

We now assume that wages are determined by bargaining between firms and individual workers. The output a worker of type k generates in firm i is given by $Q_i^k(K_i^k)$ and the additional profit the firm earns is $Q_i^k(K_i^k)(1-\tau_i)-w_i^k(1-\tau_i)-(1-\alpha\tau_i)rK_i^k$. 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

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

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

$$w_i^{k*} = (1-\beta_i^k)\overline{w}^k + \beta_i^k \frac{Q_i^k(K_i^k)(1-\tau_i)-(1-\alpha\tau_i)rK_i^k}{(1-\tau_i)}. \tag{14}$$

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

$$\frac{\partial w_i^{k*}}{\partial \tau_i} = -\beta_i^k \frac{(1-\alpha)rK_i^k}{(1-\tau_i)^2} \leq 0. \tag{15}$$

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.

Note that the effect is increasing in the bargaining power of the employee.

A.2.2 Collective wage bargaining

Assume that workers are represented by trade unions. 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 are equal to zero. After wages and employment levels are determined, firms set K_i to maximize profits:

$$\frac{\partial F(K_i, L_i^h, L_i^l)}{\partial K_i} = R_i \tag{16}$$

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

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

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

$$s_i^{k*} = \frac{(1-\beta_i^j)\beta_i^k}{(1-\beta_i^k\beta_i^j)}\frac{\Pi_i}{L_i^k(1-\tau_i)} \quad k,j = h,l, \quad k \neq j \tag{17}$$

where

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

For employment we find

$$\frac{\partial F(K_i, L_i^h, L_i^l)}{\partial L_i^k} = \overline{w}^k \quad k = h, l. \tag{18}$$

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 (17) yields

$$\frac{ds_i^{k*}}{d\tau_i} L_i^k + s_i^{k*} \frac{dL_i^k}{d\tau_i} = -\beta_0 \left((1-\alpha) r K_i\right) \leq 0 \tag{19}$$

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 (19) is equal to the change in the rent accruing to the workers of skill type k employed by firm i. This rent unambiguously declines as a consequence of the tax change. Whether the wage rate declines depends on how employment changes in response to the tax change. Equations (16) and (18) 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.

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

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

where

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

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

$$v^{k*} = \gamma_0 \frac{\sum_{i=1}^{n} \Pi_i}{\sum_{i=1}^{n} L_i^k (1-\tau_i)} \quad k,j = h,l, \quad k \neq j \tag{20}$$

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

$$\frac{\partial F(K_i, L_i^h, L_i^l)}{\partial L_i^k} = w^k \quad k = h,l \tag{21}$$

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 (20) yields

$$dv^{k*} = \gamma_0 \frac{\left[L_m^k d\tau_m - \sum\limits_{i=1}^{n} dL_i^k (1-\tau_i)\right] \sum\limits_{i=1}^{n} \Pi_i + \sum\limits_{i=1}^{n} d\Pi_i \sum\limits_{i=1}^{n} L_i^k (1-\tau_i)}{\left[\sum\limits_{i=1}^{n} L_i^k (1-\tau_i)\right]^2} \quad k, j = h, l, \quad k \neq j \tag{22}$$

where

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

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 (22) and are given by

$$\frac{\left[L_m^k - \frac{\partial L_m^k}{\partial \tau_m (1-\tau_m)}\right]}{\sum\limits_{i=1}^{n} L_i^k (1-\tau_i)} \to 0, \frac{F(K_m, L_m^h, L_m^l) - \sum_k w^k L_m^k - \alpha r K_m}{\sum\limits_{i=1}^{n} L_i^k (1-\tau_i)} \to 0. \tag{23}$$

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.

A.3 Corporate tax incidence in fair wage models

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 are given by

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

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

$$\frac{\partial f_i^k}{\partial \overline{w}_i^k}, \frac{\partial f_i^k}{\partial w_i^{-k}}, \frac{\partial f_i^k}{\partial P_i} > 0, \tag{24}$$

$$\frac{\partial f_i^k}{\partial w_i^{-k}} - \frac{\partial f_i^k}{\partial P_i} L_{-k}(1-\tau_i) > 0, \tag{25}$$

$$1 - \frac{\partial f_i^k}{\partial w_i^{-k}} \frac{\partial f_i^{-k}}{\partial w_i^k} > 0. \tag{26}$$

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 (25) 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 (26) implies that an increase in any of the reservation wages raises the fair wages of both groups.

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

$$w_i^{k*} = f_i^k(\overline{w}_i^k, w_i^{-k*}, P_i^*) \quad k = h, l. \tag{27}$$

Equation (27) 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.

Result 5 is independent of whether or not wage and capital costs are fully deductible from the tax base.

A.4 Corporate tax incidence in models where wages affect productivity

Following Acemoglu and Shimer (1999), we assume that output is uncertain and depends on the quality of firm worker matches. 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[57]:

$$\frac{\partial \rho_i}{\partial w_i} > 0, \frac{\partial_i^2 \rho}{\partial {w_i}^2} < 0, \frac{\partial_i^2 \rho}{\partial w_i^k \partial \mathbf{q}} = 0. \tag{28}$$

Expected profits are now given by

$$P_i^e = \rho_i(w_i, \mathbf{q}) Q_i(K_i)(1-\tau_j) - w_i(1-\tau_j) - (1-\alpha\tau_j) r K_i. \tag{29}$$

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

$$\frac{\partial \rho_i}{\partial w_i} Q_i(K_i)(1-\tau_j) - (1-\tau_j) = 0 \tag{30}$$

and

$$\rho_i(w_i, \mathbf{q}) Q_i'(K_i)(1-\tau_j) - (1-\alpha\tau_j) = 0. \tag{31}$$

Equations (30) and (31) 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

$$\frac{\partial w_i^*}{\partial \tau_j} = \frac{-1}{\Delta(1-\tau_j)^2} \left[\frac{\partial \rho_i}{\partial w_i} Q_i'(K_i)(1-\alpha) \right] \leq 0 \tag{32}$$

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

where

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

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 either wage or 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.

A.5 Monopolistic 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

$$\frac{\partial F(K_i, L^s(w_i))}{\partial L_i} L^{s\prime}(w_i)(1 - \tau_j) - (L^{s\prime}(w_i) w_i + L^s(w_i))(1 - \tau_j) = 0 \tag{33}$$

$$\frac{\partial F(K_i, L^s(w_i))}{\partial K_i}(1 - \tau_j) - (1 - \alpha\tau_j) r = 0 \tag{34}$$

Equations (33) and (34) 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.6 Extensions

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. 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.[58] Given that there is a uniform wage rate in the two plants, the profit tax rate is given by

$$\tau_i = \frac{\tau_1 L_1 + \tau_2 L_2}{L_1 + L_2}. \tag{35}$$

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

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

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 $\lambda^k \in (0, 1)$ stands for the relative bargaining power of the union. The

[58] This is the case for the German LBT.

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

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

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

$$s^{FA^{k*}} = \frac{\lambda^k}{(1 - \lambda^k)} \frac{P^{FAt}}{[(L_1^k + L_2^k)(1 - \tau_i) - \Phi_w^k]}, \qquad k = h, l \tag{36}$$

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 (36) 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 (36) shows that the change in the local corporate tax rate on wages is, in general, ambiguous.

A.6.2 Income shifting to avoid taxes

In this section we extend the model to include income shifting. Assume that the firm's profits are given by

$$P_{ij}^S = p_i F_i(K_i, L_i^h, L_i^l)(1-\tau_j) - \textstyle\sum_k w_i^k L_i^k (1-\tau_j) - (1-\alpha_j\tau_j) r_i K_i + \theta_{ij} S_i - c(S_i). \quad (37)$$

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.[59] Profit maximization factor 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

$$z_i^{k*} = \frac{(1-\beta_i^j)\beta_i^k}{(1-\beta_i^k\beta_i^j)} \frac{\Pi_i^S}{L_i^k(1-\tau_i)} \qquad k, j = h, l, \quad k \neq j \quad (38)$$

where

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

Differentiating (38) yields

$$\frac{dz_i^{k*}}{d\tau_i} L_i^k + z_i^{k*} \frac{dL_i^k}{d\tau_i} = -\beta_0^S[(1-\alpha) r K_i - \phi(S_i(1-\tau_f) - c(S_i))] \leq 0 \quad (39)$$

[59]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 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 themselves are not tax deductible.

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 (39) 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.

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 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.

B German business taxes

As mentioned in Section 3, there are two other profit taxes in Germany, the corporate tax (CT), 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 tax. The rate of the nationwide corporate income tax, τ_{CT}, 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. Dividends 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_{CT} 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 $\tau^{corp} = \frac{\tau_{CT} \cdot (1+soli) + t_{LBT}^{fed} \cdot \theta_{LBT}^{mun}}{1+t_{LBT}^{fed} \cdot \theta_{LBT}^{mun}}$. 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_{LBT}^{fed} for small non-corporate firms prior to 2008: for every 12,000 euros exceeding the allowance of 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.

C Descriptive Statistics

Jurisdictional changes Analogously to Figure 1, Figure C.1 shows the cross-sectional and time variation in local business tax 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 3.2, the wage data contains geographical information for the jursidictional boundaries as of December 31, 2010. In order to match the tax data, we have to bring it to the same boundaries, which generates flawed variation in tax rates, as we need to calculate population weighted average tax rate for those merged jurisdiction.

As a consequence, 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).

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

	mean	min	p5	p50	p95	max
1993	3.1	0.0	2.5	3.1	3.7	7.4
1994	3.1	1.0	2.5	3.1	3.7	5.2
1995	3.2	0.0	2.6	3.2	3.8	5.2
1996	3.2	0.0	2.6	3.2	3.8	5.2
1997	3.2	0.0	2.7	3.2	3.8	5.2
1998	3.2	0.0	2.7	3.2	3.8	9.0
1999	3.2	0.0	2.7	3.2	3.8	9.0
2000	3.2	0.0	2.7	3.2	3.8	9.0
2001	3.3	0.0	2.8	3.3	3.8	9.0
2002	3.3	0.0	2.8	3.3	3.9	9.0
2003	3.3	0.0	2.8	3.3	4.0	9.0
2004	3.3	0.0	2.8	3.3	4.0	9.0
2005	3.3	0.0	2.8	3.3	4.0	9.0
2006	3.3	0.0	2.9	3.3	4.0	9.0
2007	3.3	0.0	2.9	3.3	4.0	9.0
2008	3.3	2.0	2.9	3.3	4.0	9.0
2009	3.4	0.0	2.9	3.3	4.0	9.0
2010	3.4	2.0	3.0	3.4	4.0	9.0
2011	3.4	2.0	3.0	3.5	4.0	9.0
2012	3.5	2.0	3.0	3.5	4.0	9.0
total	3.3	0.0	2.8	3.3	4.0	9.0

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

	any change		big change	
changes	municipalities	in %	municipalities	in %
all municipalities				
0	1733	15.10	3963	34.60
1	2968	25.90	4657	40.70
2	3064	26.80	2185	19.10
3	1785	15.60	552	4.80
4	730	6.40	76	0.70
5 or more	1161	10.10	8	0.10
non-merged municipalities				
0	1636	16.40	3566	35.70
1	2832	28.30	4107	41.10
2	2898	29.00	1815	18.10
3	1659	16.60	445	4.40
4	623	6.20	63	0.60
5 or more	353	3.50	5	0.00
merged municipalities				
0	97	6.70	397	27.60
1	136	9.40	550	38.20
2	166	11.50	370	25.70
3	126	8.80	107	7.40
4	107	7.40	13	0.90
5 or more	808	56.10	3	0.20

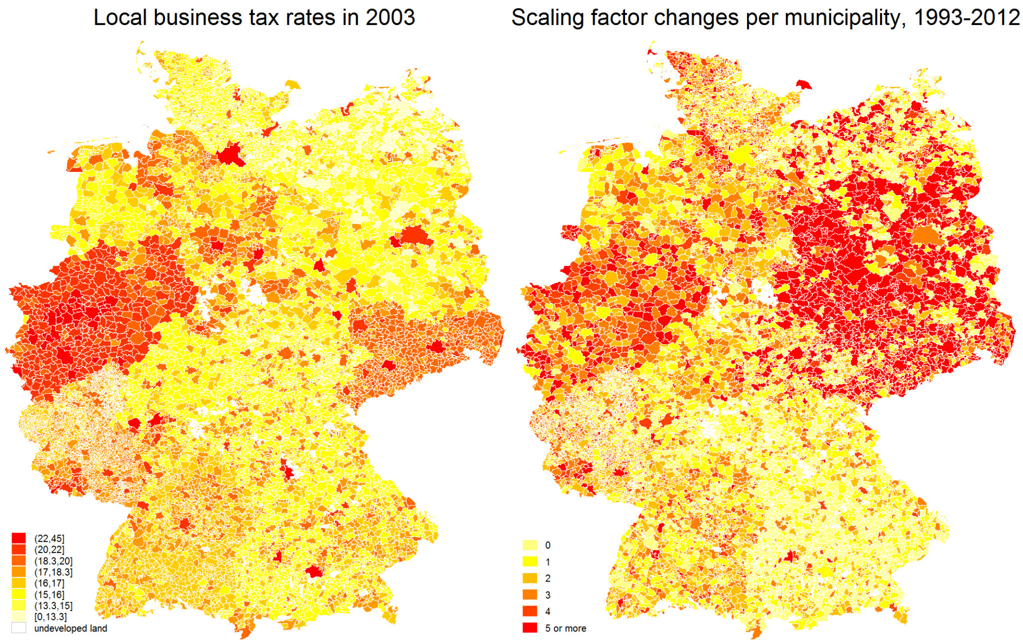
Source: Statistical Offices of the Länder. *Notes:* Big change defined as an increase the scaling factor above the mean of

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.	12.4	0.15	10.4	0.21	2.0	-0.15
non-merged municip.	9.5	0.19	8.9	0.23	0.6	-0.32
merged municip.	32.9	0.07	21.2	0.16	11.7	-0.09
by year (non-merged municipalities only)						
1994	10.9	0.18	10.1	0.24	0.9	-0.47
1995	15.6	0.19	15.0	0.22	0.6	-0.51
1996	11.2	0.16	10.7	0.19	0.5	-0.39
1997	8.6	0.18	8.1	0.22	0.5	-0.41
1998	8.7	0.18	8.2	0.22	0.5	-0.34
1999	4.3	0.12	3.7	0.20	0.6	-0.39
2000	8.8	0.12	7.9	0.17	0.9	-0.32
2001	12.9	0.15	11.8	0.19	1.1	-0.23
2002	8.3	0.17	7.8	0.20	0.5	-0.43
2003	9.7	0.20	9.3	0.22	0.4	-0.31
2004	8.5	0.19	8.1	0.21	0.3	-0.32
2005	11.5	0.18	11.1	0.20	0.5	-0.27
2006	8.4	0.14	7.5	0.19	0.9	-0.28
2007	4.1	0.11	3.3	0.20	0.8	-0.26
2008	4.0	0.18	3.2	0.28	0.8	-0.26
2009	4.2	0.18	3.5	0.27	0.8	-0.20
2010	8.8	0.27	8.4	0.30	0.4	-0.22
2011	18.5	0.29	18.2	0.29	0.3	-0.21
2012	12.9	0.26	12.6	0.27	0.3	-0.32

Source: Statistical Offices of the Länder.

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



Source: Statistical Offices of the Länder. *Notes:* This figure shows the cross-sectional and time variation in municipal scaling factors of the German LBT. 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.4: Descriptive statistics, plant sample, non-merged municipalities, 1998-2008

	mean	p50	sd
Wage	2,731	2,723	861
Local scaling factor	3.76	3.70	0.52
LBT rate (in %)	18.17	18.00	3.06
Municipal expenses (in 1000)	370,083	53,865	791,081
Municipal population	111,042	30,901	202,395
District unemployment rate	0.11	0.09	0.05
District GDP (in Mio)	8,980	5,594	11,588
Share: West German municipalities	0.84	1.00	0.37
Number of employees	273	57	1158
Value added (in 1000)	175,407	2632	5,913,389
Investments (in 1000)	3649	172	26,759
Share: Liable plants	0.64	1.00	0.48
Share: Sector level bargaining	0.58	1.00	0.50
Share: Firm level bargaining	0.08	0.00	0.27
Share: No collective bargaining	0.33	0.00	0.47
Share: Manufacturing	0.28	0.00	0.45
Share: Construction	0.07	0.00	0.26
Share: Trade	0.04	0.00	0.19
Share: Services	0.28	0.00	0.45
Share: Public/Utilities	0.33	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	0.61	1.00	0.49
Share: German owner	0.94	1.00	0.24

Source: LIAB and Statistical Offices of the Länder. *Notes:* Total number of plant-year observations: 56,443. Number of plants: 16,435. All money variables in 2008 euros.

Table C.5: Descriptive statistics, worker sample, non-merged municipalities, 1998-2008

	mean	p50	sd
Wage	3,508	3,375	1,086
Local scaling factor	3.95	4.00	0.54
LBT rate (in %)	19.17	19.35	3.18
Municipal expenses (in Thsd.)	751,491	248,334	1,124,351
Municipal population	213,347	89,437	285,6421
District unemployment rate	0.10	0.09	0.04
District GDP (in million)	14,098	8,177	16,300
Share: West German municipalities	0.92	1.00	0.26
Number of employees	5,665	1148	11,452
Value added (in Thsds.)	3,669,463	103,434	3,280,000
Investments (in Thsds.)	79,487	6,752	204,510
Share: Liable firms	0.74	1.00	0.44
Age	41	42	10
Share: Male	0.73	1.00	0.44
Share: High-skilled	0.14	0.00	0.34
Share: Medium skilled	0.72	1.00	0.45
Share: Low-skilled	0.14	0.00	0.35
Share: Blue collar	0.54	1.00	0.50
Share: Never censored individuals	0.81	1.00	0.39

Source: LIAB and Statistical Offices of the Länder. *Notes:* Number of person-year observations: 9,707,702. Number of individuals: 3,176,199. All money variables in 2008 euros.

Table C.6: Percentiles of the share of non-wage-censored workers across firms

	p1	p5	p10	p25	p50	p75	p90	p95	p99	obs
manuf.	0.45	0.71	0.80	0.90	0.97	1	1	1	1	21, 790
service	0.34	0.61	0.74	0.88	0.98	1	1	1	1	14, 324
total	0.40	0.67	0.78	0.89	0.97	1	1	1	1	36, 114

Source: LIAB. *Notes:* This table shows the distribution of the share of non-wage-censored workers across firms in different sectors. Workers are wage-censored if they earned more than the social security contributions earnings ceilings at least once in the sample.

D Additional Results

Table D.1: Effect on firm wages – baseline event study estimates

sample	(1) All	(2) Liable	(3) Non-liable
$\hat{\gamma}_{-4} \times 100$	0.030	0.004	0.089
	(0.112)	(0.136)	(0.202)
$\hat{\gamma}_{-3} \times 100$	0.026	-0.083	0.226^{*}
	(0.091)	(0.122)	(0.128)
$\hat{\gamma}_{-2} \times 100$	-0.034	-0.155	0.163
	(0.080)	(0.107)	(0.118)
$\hat{\gamma}_{0} \times 100$	-0.022	-0.017	-0.013
	(0.071)	(0.087)	(0.133)
$\hat{\gamma}_{1} \times 100$	0.001	-0.286^{*}	0.483^{*}
	(0.138)	(0.165)	(0.247)
$\hat{\gamma}_{2} \times 100$	-0.312^{*}	-0.549^{***}	0.130
	(0.165)	(0.208)	(0.272)
$\hat{\gamma}_{3} \times 100$	-0.386^{**}	-0.629^{***}	0.105
	(0.186)	(0.244)	(0.291)
$\hat{\gamma}_{4} \times 100$	-0.428^{**}	-0.619^{**}	-0.081
	(0.201)	(0.266)	(0.333)
$\hat{\gamma}_{5} \times 100$	-0.393^{*}	-0.842^{***}	0.439
	(0.229)	(0.310)	(0.393)
N	56,404	36,117	20,287

Source: LIAB. *Notes:* This table shows the regression estimates depicted in Figure 2 – see figure and respective note for more information. Standard errors are clustered at the municipal level. Significance levels are $^{*} < 0.10$, $^{**} < 0.05$, $^{***} < 0.01$.

Table D.2: Differences-in-differences estimates at firm level: robustness to other controls

	(1)	(2)	(3)	(4)	(5)
LBT rate ($\hat{\delta} \times 100$)	-0.487^{***}	-0.492^{***}	-0.545^{***}	-0.504^{***}	-0.600^{***}
	(0.165)	(0.165)	(0.176)	(0.154)	(0.170)
Firm employment		✓			
Munic. expenses			✓		
Worker shares				✓	
Share of nevercensored					✓
N	36,141	36,141	33,529	36,141	36,141

Source: LIAB. *Notes:* This table presents the DiD estimates ($100 \times \hat{\delta}$) of regression model (4). Transformed coefficients measure the semi-elasticity of the wage with respect to a one percentage point increase in the LBT. All specifications include firm and municipal fixed effects, as well as "state × year" fixed effects. In addition, the model is estimated for various sets of control variables (as indicated at the bottom of the table). Our baseline model without further controls is shown in column (1). In column (2), firm employment is added. In model (3), we add current and future (one and two years ahead) municipal spending. Specification (4) accounts for different worker shares at the firm level (by skill [high vs medium vs low], gender, age-group [old vs mid-aged vs young], employment type [full-time vs part-time] and occupation [white-collar vs blue-collar]). In column (5), the share of workers whose wages have never been censored is included. The estimation sample comprises all establishments liable to the LBT in non-merged municipalities. Standard errors are clustered at the municipal level. Significance levels are $^{*} < 0.10$, $^{**} < 0.05$, $^{***} < 0.01$.

Table D.3: Differences-in-differences estimates: robustness clustering

	(1)	(2)	(3)	(4)	(5)	(6)
LBT rate ($\hat{\delta} \times 100$)	-0.487^{***}	-0.487^{***}	-0.487^{***}	-0.487^{***}	-0.487^{***}	-0.487^{***}
	(0.165)	(0.133)	(0.167)	(0.169)	(0.154)	(0.165)
N	36,141	36,141	36,141	36,141	36,141	36,141
Clustering at level of	muni	muni×year	county	CZ	state	firm
Clusters	2,816	14,574	390	252	13	10,932

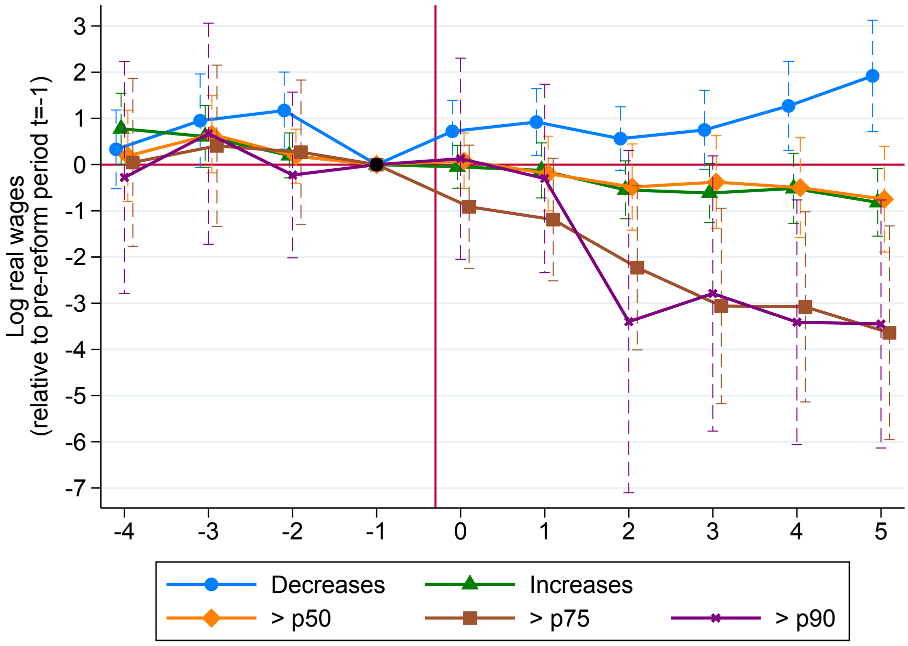
Source: LIAB. *Notes:* This table presents the DiD estimates ($100 \times \hat{\delta}$) of regression model (4). Transformed coefficients measure the semi-elasticity of the wage with respect to a one percentage point increase in the LBT. All specifications include firm and municipal fixed effects, as 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. Significance levels are $^{*} < 0.10$, $^{**} < 0.05$, $^{***} < 0.01$.

Table D.4: Calculating the tax incidence

	(1) Coefficient $\hat{\delta} \times 100$	(2) Euro measure $\frac{d(wL)}{d(\tau T)}$	(3) Incidence $\frac{d(wL)}{d(\tau T)} \cdot \frac{1}{(1+MEB)}$
All	-0.220^{*}	-0.291^{*}	-0.224^{*}
	(0.126)	(0.158)	(0.122)
Liable	-0.487^{***}	-0.604^{***}	-0.464^{***}
	(0.165)	(0.183)	(0.140)
Non-liable	0.246	0.367	0.283
	(0.197)	(0.313)	(0.241)
Manufacturing	-0.597^{***}	-0.722^{***}	-0.555^{***}
	(0.207)	(0.218)	(0.168)
Construction	-0.581^{*}	-0.705^{*}	-0.542^{*}
	(0.344)	(0.365)	(0.281)
Trade	−0.307	−0.397	−0.306
	(0.490)	(0.589)	(0.453)
Service	-0.475^{*}	-0.591^{*}	-0.454^{*}
	(0.286)	(0.318)	(0.245)
Firm	-1.100^{**}	-1.194^{***}	-0.919^{***}
	(0.487)	(0.416)	(0.320)
Sector	-0.495^{***}	-0.613^{***}	-0.471^{***}
	(0.166)	(0.183)	(0.141)
No CBA	−0.392	−0.497	−0.382
	(0.327)	(0.378)	(0.291)
Single plant	-0.589^{***}	-0.713^{***}	-0.549^{***}
	(0.211)	(0.223)	(0.172)
Multi plant	−0.187	−0.249	−0.192
	(0.226)	(0.288)	(0.221)

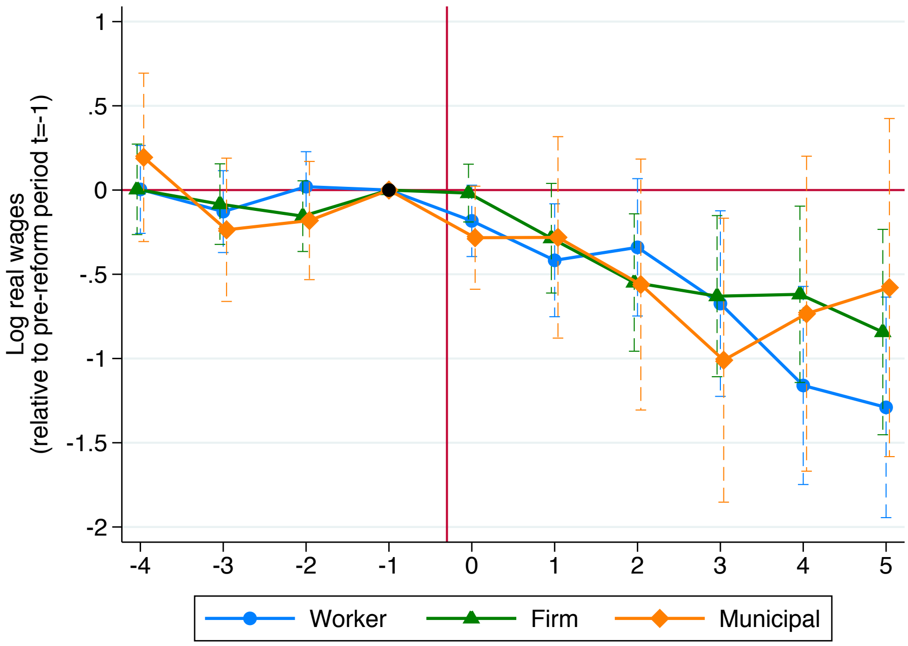
Source: LIAB. *Notes:* This table summarizes the effects of a change in the LBT on wages for various types of firms in non-merged municipalities. The effect on wages is presented in various ways. Column (1) shows the DiD estimates ($100 \times \hat{\delta}$) of regression model (4). Transformed coefficients measure the semi-elasticity of the wage with respect to a one percentage point increase in the LBT. Column (2) translates the estimates into an euro measure indicating the response in the wage bill to a one euro increase in the tax bill. The measure is calculated by plugging the regression estimates for $\hat{\delta}$ into formula (5). We apply the average LBT of $\tau = 0.18$ as observed in our data. Furthermore, we set $T/wL = 0.72$, based on official tax and labor statistics (*Gewerbesteuerstatistik* and *Arbeitskostenerhebung*, see `https://www.destatis.de/EN/FactsFigures/FactsFigures.html`). Column (3) presents and incidence measure, which is based on the euro measure, but additionally takes into account the marginal cost of public funds, which is assumed to be 0.3. Standard errors for the euro and incidence measures are calculated using the Delta method. Significance levels are $^{*} < 0.10$, $^{**} < 0.05$, $^{***} < 0.01$.

Figure D.1: Effects on firm wages – non-parametric event study



Source: LIAB and Statistical Offices of the Länder. *Notes:* All curves depict event study estimates ($100 \times \hat{\gamma}_j, j \in [-4, 5]$) and the corresponding 95% confidence bands obtained by estimating equation (2). Event variables are dummies equal to one for a tax increase, a tax decrease or an tax increase of a specific size (larger than different percentiles of the tax increase distribution, see legend). Transformed coefficients measure the semi-elasticity of the wage with respect to an average increase/decrease in the LBT. The tax change occurred for the treatment group on 1 January in event year $t = 0$, as indicated by the vertical red line. Wages are observed on 30 June for each year. All regression models include municipal, firm and "state × year" fixed effects. The estimation sample comprises all establishments in non-merged municipalities. For the specifications with event dummies for tax increases, we exclude all municipalities that experienced a tax decrease during the observation period. For the specification looking at tax decreases, we cannot make an analogous adjustments as the sample size would be too small. Standard errors are clustered at the municipal level.

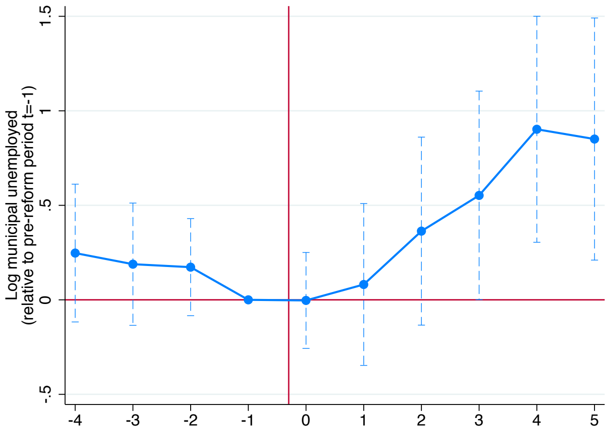
Figure D.2: Effects on firm wages – at different aggregation levels



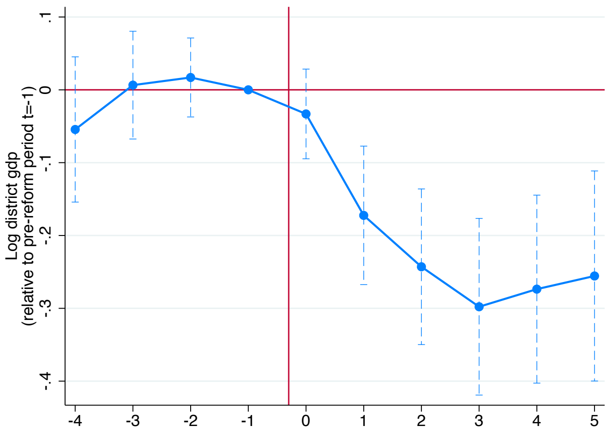
Source: LIAB and Statistical Offices of the Länder. *Notes:* All curves depict event study estimates ($100 \times \hat{\gamma}_j, j \in [-4, 5]$) and the corresponding 95% confidence bands obtained by estimating equations (2), (6) and (8), using event variable definition (3). Transformed coefficients measure the semi-elasticity of the wage with respect to a one percentage point increase in the LBT. The tax change occurred for the treatment group on 1 January in event year $t = 0$, as indicated by the vertical red line. Wages are observed on 30 June for each year. All regression models include municipal, firm and "state × year" fixed effects. The estimation sample comprises all non-merged municipalities for estimations at the municipal level, all liable establishments in non-merged municipalities for firm-level estimations and all workers in liable establishments in non-merged municipalities for results at the individual level. Standard errors are clustered at the municipal level.

Figure D.3: Effects on local unemployment

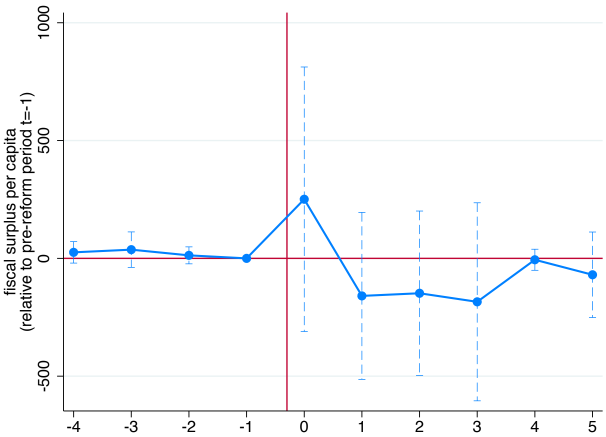
Panel A: Effects on municipal unemployment



Panel B: Effects on county-level GDP



Panel C: Effects on municipal fiscal surplus



Source: Statistical Offices of the Länder. *Notes:* All curves depict event study estimates ($100 \times \hat{\gamma}_j, j \in [-4, 5]$) and the corresponding 95% confidence bands obtained by estimating equation (6), using event variable definition (3). instead of the log wage, the dependent variables in Panel A, B and C are the log number of municipal unemployed, the log county GDP and the municipal fiscal surplus (revenues minus expenses), respectively. For panels A and B, the transformed coefficients measure the semi-elasticity of the outcome with respect to a one percentage point increase in the LBT. In Panel C, the coefficients measure the unit change of the outcome with respect to a one percentage point increase in the LBT. 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 control for log population and include municipal and "state × year" fixed effects. The estimation sample comprises all non-merged municipalities. Standard errors are clustered at the municipal level.

E Event study design

The following Appendix is intended to clarify the event study design we implement in the empirical part of the paper. While the intuition of event study designs is easy to understand, the implementation involves adjustments that are not so obvious but very important to obtain correct results. This is especially true in situations that deviate from the standard event study with one equally sized event per unit. The following exposition heavily draws on the paper by Sandler and Sandler (2014).

E.1 Empirical specification

In our study, we implement an event study design to estimate the effect of local business taxes on wages. Compared to the classical event study designs that originated in financial economics, there are two differences that we need to account for in the empirical specification. First, we observe multiple events per unit of observation, as some municipalities change tax rates more than once during the sample period. Second, the tax changes, that is the events, are of different sizes (and sometimes even of different signs), which is an additional piece of information, we can make use of. As a reference point, we start with a classical event study set-up, in which each unity experiences only one event. First, we introduce multiple event (of the same size) and then allow for the possibility of different event.

The classic set-up The classic empirical model is described by the following equation:

$$Y_{i,t} = \sum_{j=A}^{B} \gamma_j D_{i,t}^{j} + \mu_i + \mu_t + \varepsilon_{i,t} \tag{40}$$

where $Y_{i,t}$ is the outcome variable (in our case the wage in firm i at time t). The main regressors of interest are the event dummy variable $D_{i,t}^{j}$, which are equal to one if an event (i.e. a tax change) occurred j periods ago. The parameters $A < 0$ and $B > 0$ are constants that define the event window. Consider a firm i with a tax reform in 2005. For this firm, it follows, for instance, that $D_{i,2003}^{-2} = D_{i,2004}^{-1} = D_{i,2005}^{0} = D_{i,2006}^{1} = D_{i,2007}^{2} = 1$. Finally, μ_i and μ_t are firm and year fixed effects.

Even in this simple set-up with only one tax change, it is important to adjust the endpoints of the event window A, B. As events happen in different years for different firms, we do not face a balanced panel in event time. The usual approach to account for this is to bin up endpoints (McCrary, 2007). Letting e_i denote the year of the event for municipality i, the event dummies are defined as follows:

$$D_{i,t}^{j} = \begin{cases} D_i \mathbf{1}[t \leq e_i + j] & \text{if } j = A \\ D_i \mathbf{1}[t = e_i + j] & \text{if } A < j < B \\ D_i \mathbf{1}[t \geq e_i + j] & \text{if } j = B \end{cases} \tag{41}$$

Moreover, the system of event dummy coefficients γ_j is perfectly collinear, so not all parameters can be identified. It is common to normalize the pre-event coefficient to zero, $\gamma_{-1} = 0$, which is also what we do in our model.

Adjusting to multiple tax changes Now, assume that multiple events per firm may occur. In the classic example, event dummies for each firm-year observation were mutually exclusive. Now it is possible that several event dummies are switched on for a given firm-year observation. We consequently need to adjust notation slightly. The variable e_i, indicating the date of the tax reform for firm i, cannot contain all necessary information as there may be multiple reforms per firm. Hence, we define for each firm i a $1 \times M_i$ row vector, $\mathbf{e}_i^m$, containing all dates of the M_i events experienced by the firm. It follows that $\mathbf{e}$ can be of different length depending on the firm. Last, denote e_i^m the element contained in row m of $\mathbf{e}$. The new set-up also has implications for the definition of event dummies, which are defined as follows:

$$D_{i,t}^{j} = \begin{cases} D_i \sum_{m=1}^{M_i} \mathbf{1}[t \leq e_i^m + j] & \text{if } j = A \\ D_i \sum_{m=1}^{M_i} \mathbf{1}[t = e_i^m + j] & \text{if } A < j < B \\ D_i \sum_{m=1}^{M_i} \mathbf{1}[t \geq e_i^m + j] & \text{if } j = B \end{cases} \tag{42}$$

As only one event can occur in a given year $D_{i,t}^j$ can only take values of zero for $A < j < B$. In contrast, event dummies at the two ends of the event window ($D_{i,t}^j,\ j \in A, B$) can take values larger than one. Note that equation (42) is more general and nests equation (41) for the special of $M_i = 1,\ \forall i$, i.e. if there is only one event per firm.

There is a different way to write expression (42) using information on the endpoints of the sample. Define two constants $\bar{A}$ and $\bar{B}$, which denote the last and the first year of the estimation sample, hence the endpoints of the data. Define $T_{i,t}$ as a dummy variable, indicating an event in firm i at time t. Hence, $T_{i,t} = D_i \sum_{m=1}^{M_i} \mathbf{1}[t = e_i^m]$. With this new notation, event dummy definition given by (42) can be rewritten as

$$D_{i,t}^{j} = \begin{cases} \sum_{k=A}^{\bar{A}-t} T_{i,t-k} & \text{if} \quad j = A \\ T_{i,t-j} & \text{if} \quad A < j < B \\ \sum_{k=B}^{t-\bar{B}} T_{i,t-k} & \text{if} \quad j = B \end{cases} \tag{43}$$

A nice feature of this notation is that it can be used for the case of one tax change per firm and for the case of multiple tax changes. For instance, event dummy $D_{i,t}^{A}$ sums up all event dummies occurring between A (the maximum lead within the event window) and $\bar{A}$ the last observed data year. Consider a firm i, which experiences two reforms in 2005 and 2007. Let the event window be set such that $A = -2$ and $B = 2$. Moreover, $\bar{A} = 2007, \bar{B} = 2002$. For $t = 2003$, $D_{i,2003}^{-2} = \sum_{k=-2}^{-4} T_{i,2003-k} = T_{i,2005} + T_{i,2006} + T_{i,2007} = 1 + 0 + 1 = 2$.

Accounting for different event sizes The second adjustment we make is to exploit information on different sizes of the events, which seems worthwhile when events are tax reforms. A downside of this extension is that the non-parametric nature of the event study design with dummy variable has to be partly sacrificed. In fact, we will make the linear assumption that an event size of $2x$ has an effect on the outcome which is two times larger than an event of size x. Formally, we simply scale the event study coefficients given in equation (43) with the size of the tax rate change $\Delta\tau_{i,t}$.

$$D_{i,t}^{j} = \begin{cases} \sum_{k=A}^{\bar{A}-t} T_{i,t-k} \cdot \Delta\tau_{i,t-k} & \text{if } j = A \\ T_{i,t-j} \cdot \Delta\tau_{i,t-j} & \text{if } A < j < B \\ \sum_{k=B}^{t-\bar{B}} T_{i,t-k} \cdot \Delta\tau_{i,t-k} & \text{if } j = B \end{cases} \tag{44}$$

There are various things to note when digesting the event study definition given in equation (44). First, if there is no tax change in t ($\Delta\tau_{i,t} = 0$), there was no tax reform in t, ($T_{i,t} = 0$). Hence, the event dummies $T_{i,t}$ are redundant and we can write

$$D_{i,t}^{j} = \begin{cases} \sum_{k=A}^{\bar{A}-t} \Delta\tau_{i,t-k} & \text{if } j = A \\ \Delta\tau_{i,t-j} & \text{if } A < j < B \\ \sum_{k=B}^{t-\bar{B}} \Delta\tau_{i,t-k} & \text{if } j = B \end{cases} \tag{45}$$

Second, it might seem unintuitive to regress levels on changes, given that we assume a functional relationship between wage levels and tax levels. Consider two municipalities A and B changing their tax rates only once during the sample period. They change the tax rate by the same amount, say 5 percentage points, but have different tax levels, with municipality A having pre-reform tax rate of 15% and B a rate of 25%. In a (log)-linear model the increase in the tax rate should have the same effect on the (relative) wage. Given that the municipality-specific wage level, which includes the initial tax level, is captured in the municipality fixed effect μ_i (see equation (40)). Scaling the tax reform dummies by the after-reform tax level, would imply that the tax change in municipality B was twice as large as in municipality A. This would yield largely biased results.

E.2 Simulations

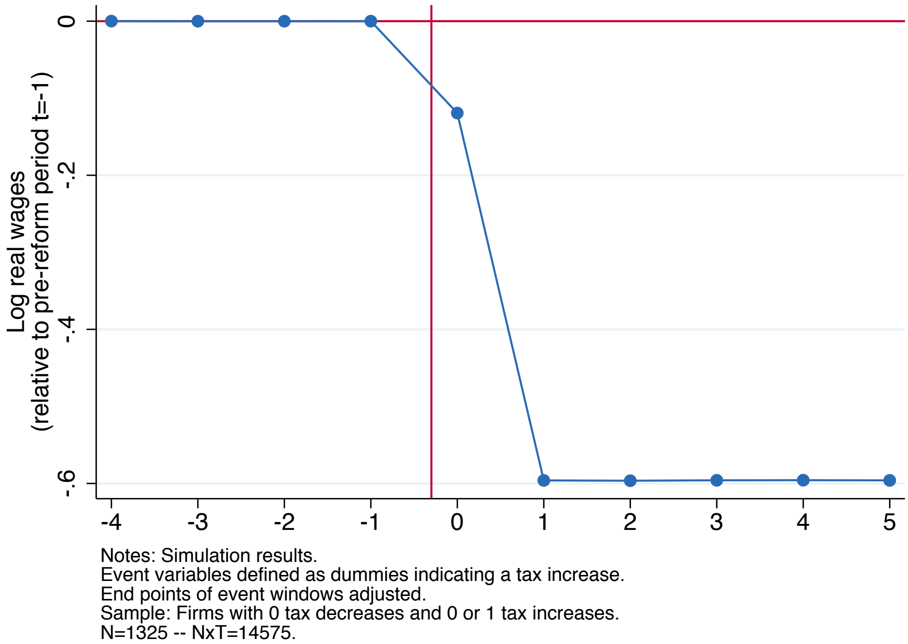
In order to demonstrate the performance of our event study set-up in relation to more conventional specifications, we conduct a simulation. The data generation process is replicating the structure of out wage data. The log wage in firm i at time t is determined by:

$$\ln wage_{i,t} = \mu_i - 0.1\tau_{i,t} - 0.4\tau_{i,t-1} + 6t - 0.001t^2 \tag{46}$$

where μ_i is a normal distributed random variable, $\mu_i \sim \mathcal{N}(8, 1)$, and $Cov(\mu_i, \tau_{i,t}) \neq 0$. We replicate the structure of the real data with tax increases happening with a probability of 9.5% and decreases with a probability of 3.4%. Last, there is a positive wage trend in the data. We estimate the event study design as given by equation (40) and set $A = -4$ and $B = 5$.

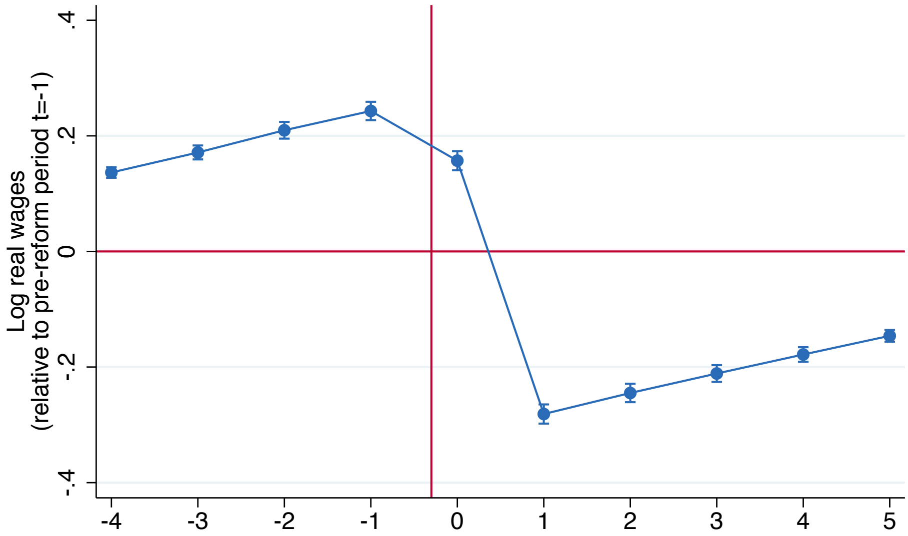
The classical set-up In a first step, we only focus firms with one tax *increase* and define event dummies according to equation (41), hence we implement a pure dummy variable specification, where dummies indicate an increase in the tax rate. Results are shown in Figure E.1. With an average tax rate increase of 1.19 points, the event study design provides the correct estimates, as wages are 0.6% lower after a reform, which implies that a 1 percentage point tax increase lowers wages by $\frac{0.6\%}{1.19} = 0.5\%$.

Figure E.1: Simple tax increase dummies, at most one increase per firm



In a first step, we want to highlight the necessity to adjust the dummies at the two ends of event window so that they take into account tax reforms outside the event window as done in McCrary (2007). Failure to do so leads to incorrect event study coefficients as shown in Figure E.2. First, the set of event dummies is not perfectly collinear so there is no natural normalization of one of the event dummies. Take the example of a single firm. If end points are modified, at any time t one of the event dummies will be switched on, so one has to be dropped. If end points are not adjusted and we consider a year that is sufficiently far away from the event, all dummies are switched off. These years can be used to identify all event coefficients. Second, while the jump in the coefficients due to the reform is roughly equal to 0.7, there is a general trend upward after the reform. This general trends is due to the terms $6 \cdot t - 0.001 \cdot t^2$ in the data generation process given in equation (46). With a negative overall trend of say, $-6 \cdot t + 0.001 \cdot t^2$, trends in the event study graph would be negative.

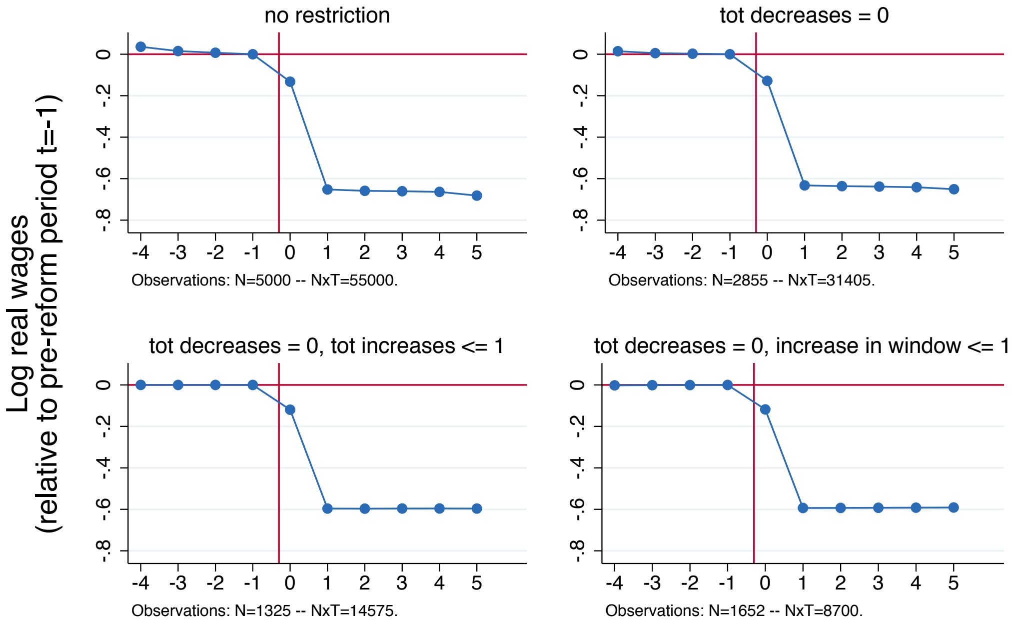
Figure E.2: Simple tax increase dummies, at most one increase per firm



Notes: Simulation results.
Event variables defined as dummies indicating a tax increase.
End points of event windows not adjusted.
Sample: Firms with 0 tax decreases and 0 or 1 tax increases.
N=1325 -- NxT=14575.

Multiple tax changes In a next step, we allow for multiple events to happen. Hence, we implement the event dummies according to equation (43). Figure E.3 presents the results. In the top-left panel, we loosen the sample restriction and take into account all firms: those with multiple tax changes, including decreases. We detect a slight and actually significant pre-trend in period $j = -4$. The negative pre-trend becomes stronger with the share of firms facing a tax decrease. In a similar vain, we detect a further decrease in wages after period $j = 2$, which is not warranted by the data generating process. The reason for this overall downward trend is that our control group contains municipalities that experience tax decreases, which is not detected by the model. These unmodeled tax increases yield positive wage effects, which eventually make the observed tax effect more negative than it is. In top right Panel, we demonstrate this mechanism by dropping all firms that experience a tax decrease at some point during the observation period from our sample. The negative trend becomes smaller, but there is a remaining bias in the pre-period. The bias vanishes as soon as, we restrict the number of tax increase per firm to more at least one as shown in Figure E.3, bottom-left panel. Restricting the sample to firm-year observation with an increase within the event window (bottom right panel), yields similar results.

Figure E.3: Simple tax increase dummies, multiple events



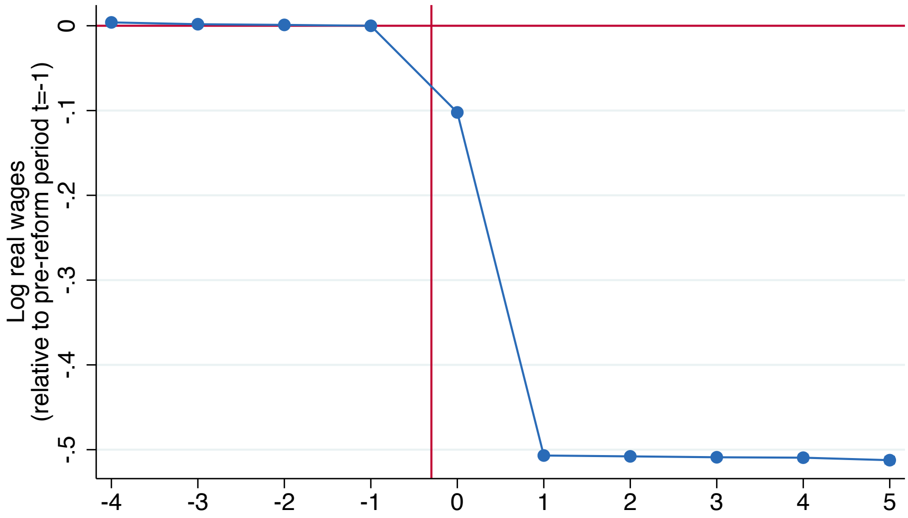
Notes: Simulation results.
Event variables defined as dummies indicating a tax increase.
End points of event windows adjusted.

Accounting for different event sizes Last, we account for different event sizes. As seen in Figure E.3, including firms that experience tax increases and decreases induces a bias in the estimates. A way to overcome this bias is actually accounting for the event size by specifying event dummies according to equation (44). Figure E.4 show the results from the most comprehensive specification: including all firm-years (multiple increases and decreases), weighing event dummies with the size of the change, and binning up the end points of the event window. As described above, the magnitude of the coefficients is normalized such that we consider a one percentage point increase in the tax rate.

We find identical results when restricting the sample (i) to firms that have never experienced a decrease, (ii) to firms that have only experienced one increase, (iii) firm-year observation with only one increase in the event window (not shown). Again, if we combine restrictions (ii) and (iii), hence look at firms with only one increase and only include the firm-year observations where the change is happened in the event window, we introduce a small bias (see Figure E.5).

As a last test, we implement a specification, in which we scale event dummies with the level of the tax rate (instead of with the change). Panel A of Figure E.6 show that we are able to estimate the tax effect correctly. However, the specification fails to pick up the permanent effect of the tax change on wages reflected by the coefficient $t = 2, t = 3, t = 4$.

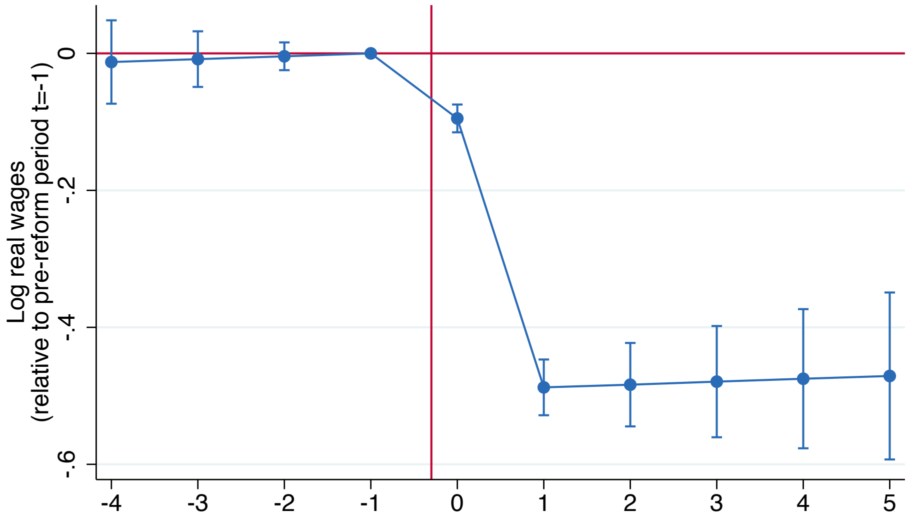
Figure E.4: Tax *change* weighted reform dummies, all firms, binning



Notes: Simulation results.
Event variables defined as dummies indicating a tax change (increase or decrease), multiplied/scaled by the size of the tax change.
End points of event windows adjusted.
Sample: All firms.
N=5000 -- NxT=55000.

The problem persists if we restrict the sample to firms with only one tax increase (see Panel B)

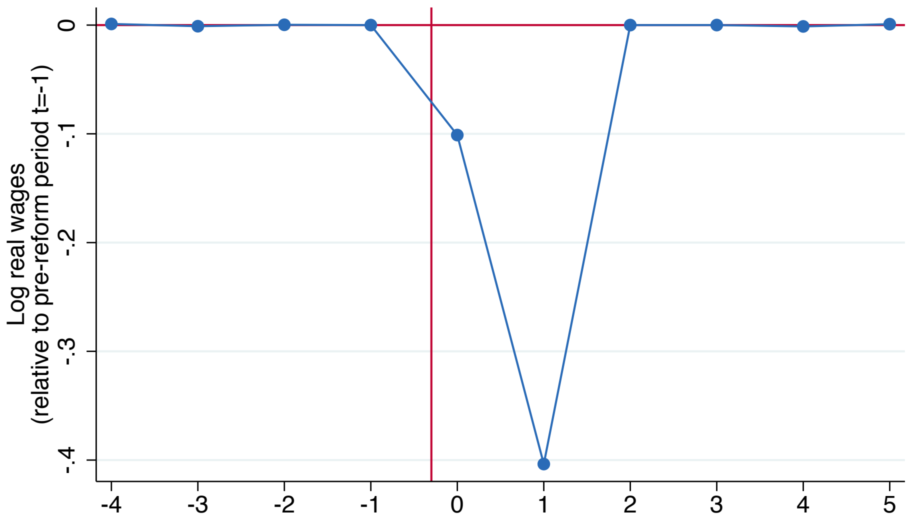
Figure E.5: Tax *change* weighted reform dummies, one increase per firm, one increase in window, binning



Notes: Simulation results.
Event variables defined as dummies indicating a tax change (increase or decrease), multiplied/scaled by the size of the tax change.
End points of event windows adjusted.
Sample: Firms with 0 tax decreases, 0 or 1 tax increases and 1 increase in event window.
N=685 -- NxT=3814.

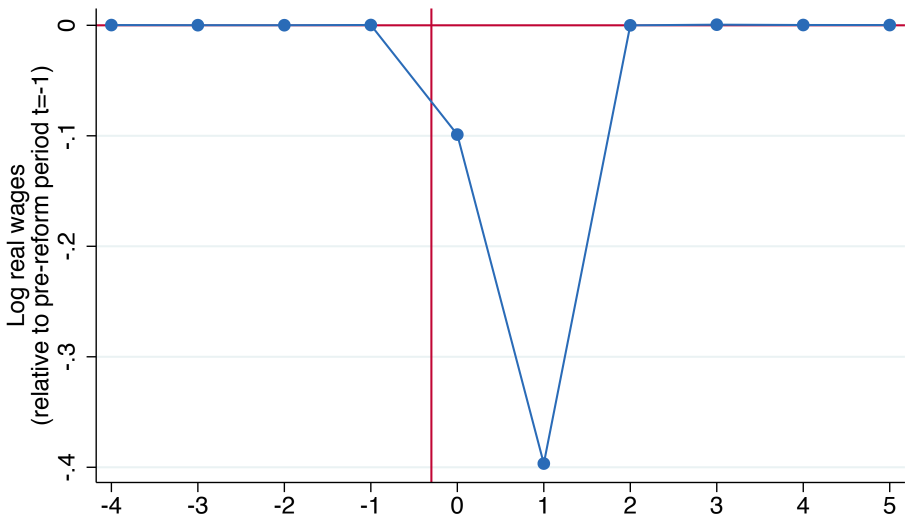
Figure E.6: Tax *rate* weighted reform dummies, binning

Panel A: All firms



Notes: Simulation results.
Event variables defined as dummies indicating a tax change (increase or decrease), multiplied/scaled by the level of the tax rate.
End points of event windows adjusted.
Sample: All firms.
N=5000 -- NxT=55000.

Panel B: Firms with one increase



Notes: Simulation results.
Event variables defined as dummies indicating a tax change (increase or decrease), multiplied/scaled by the level of the tax rate.
End points of event windows adjusted.
Sample: Firms with 0 tax decreases and 0 or 1 tax increases.
N=1325 -- NxT=14575.