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Do place-based tax incentives create jobs? ☆

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ABSTRACT

In this paper, we evaluate the effectiveness of place-based payroll taxes in stimulating local employment by exploiting a unique policy setting in Norway, where a system of geographically differentiated payroll taxes was suddenly abolished due to an EU regulation. The reform was enforced independently of the regional labor market developments, creating arguably exogenous variation in the payroll tax rates that firms in different local labor markets faced over time. We find evidence of partial shifting of payroll tax increases on to worker wages as well as a significant decline in local employment. These findings suggest that in settings with some degrees of wage rigidity, place-based payroll tax incentives can be effective in stimulating local employment.

1. Introduction

As highlighted in a recent review by Kline and Moretti (2014a), most countries exhibit large and persistent geographical differences in income and employment, and a growing class of place-based policies attempt to reduce these differences through targeting underdeveloped or economically distressed regions. The most prominent and extensively studied place-based policies include enterprise zones such as the Empowerment Zone Program in the U.S. (Busso et al., 2013); infrastructure investment such as the Appalachian Regional Commission (Glaeser and Gottlieb, 2008) and the Tennessee Valley Authority (Kline and Moretti, 2014b) in the U.S. and EU structural funds (Becker et al., 2010, 2012) in Europe; and discretionary subsidy policies such as the Regional Selective Assistance program in the UK (Devereux et al., 2007; Criscuolo et al., 2019).[1]

A form of policy that has received less attention in this literature is place-based payroll tax incentives commonly used in Finland, Norway, and Sweden (see Korkeamäki and Uusitalo, 2009; Johansen and Klette, 1997; Bennmarker et al., 2009). Payroll taxes are the backbone of financing the social insurance system in these countries, and payroll taxes levied on firms constitute about 15% of the total tax revenue in OECD countries.[2] As payroll taxes are proportional to workers' earnings, they serve as an additional labor cost for firms, beyond the gross wages paid to employees. To stimulate employment in remote areas, and thereby reduce regional disparities in labor market opportunities, governments of Finland, Sweden and Norway (used to) apply geographically differentiated payroll tax rates. Norway for instance, had, from

[1] See Bartik (2001, 2003), Kline and Moretti (2014a), and Neumark and Simpson (2015) for an overview of this literature.
[2] Tax Foundation, p. 8: https://files.taxfoundation.org/20170830115300/Tax-Foundation-FF557.pdf

the 1970s and up until 2003, five tax zones with payroll tax rates ranging from 0% in the northernmost regions to 14.1% in the central areas.

In this paper, we investigate whether such place-based payroll tax incentives are indeed effective in boosting employment in low tax areas, by looking at the case of Norway. The key challenge to evaluating geographically differentiated payroll taxes is that the prevailing tax rates in different regions likely reflect the regional economic conditions or developments. This makes it difficult to separate the impacts of different payroll tax rates on employment and wages from the effects of local labor market conditions or business cycles. We overcome this challenge by exploiting a unique policy setting in Norway in the mid-2000s, where the system of geographically differentiated payroll taxes was suddenly abolished.

Prior to the reform, the government of Norway allowed lower payroll tax rates in remote areas to stimulate employment and business activity, and to avoid depopulation of sparsely populated areas of the country. In 1999, however, the European Free Trade Association Surveillance Authority (ESA) ruled that the Norwegian system of geographically differentiated payroll tax rates was not in compliance with European Union (EU) trade regulations. The result was a tax rate harmonization reform that took place between 2004 and 2006. The reform was adopted and implemented independently of the local labor market developments and thereby created (arguably) exogenous variation in the payroll tax rates faced by firms in different regions over time. At the same time as complying with the EU ruling of a tax harmonization, the Norwegian government implemented a subsidy scheme that essentially rendered small firms exempt from the payroll tax increase.

Our analysis takes advantage of the EU-induced payroll tax changes at the level of the local labor market or commuting zone (there are 45 commuting zones in Norway excluding Oslo).[3] Specifically, we compare changes in employment and wages before (2000−2003) and after (2004−2006) the abolition of geographically differentiated payroll taxes between commuting zones that are differentially exposed to the policy. Even though there are just five tax zones, there is variation in payroll tax increases across the 45 commuting zones. First, and most importantly, this is because 23 out of the 45 commuting zones span more than one tax zone. Second, the relevant tax rates are determined by the location of the worker rather than that of the firm or establishment, and commuting zones may differ with respect to their propensity to hire workers from different locations.

We find that a 1% age point increase in the payroll rate tax leads to a decline in wages in the local labor market of 0.32%; although this effect is imprecisely estimated. Taking into account that only large firms—which employ about 70% of workers in the local labor market—are subject to the payroll tax increase in our context (see Section 2 for details), this wage response implies a pass-through rate of 0.46%, a rate comparable to that found in Holmlund (1983) and Johansen and Klette (1997) for earlier periods in Sweden and Norway.[4] We further find a significant decrease in local employment in response to the payroll tax hike: a one percentage point increase in the payroll tax rate reduces employment in the local labor market by 1.37%. The employment decline is largely driven by workers transitioning from employment to un- or non-employment rather than worker relocation (i.e., outmigration to different commuting zones).[5,6]

When viewed through the lens of a perfectly competitive model where firms choose inputs to maximize profits, and taking into account that only large firms are subject to the payroll tax hike, our wage and employment responses imply a labor demand elasticity of −3.60. This estimate falls in the upper range of estimates reported in the literature (see e.g., Lichter et al., 2015 for a meta study). One possible explanation for such a large labor demand elasticity is that capital is fixed over the three-year study period.[7] An alternative explanation is one based on liquidity constraints, as recently put forward by Saez et al. (2019). The idea here is that liquidity-constrained firms faced with an unexpected windfall loss (in our context caused by a payroll tax hike) may be forced to bring down labor costs quickly to lessen the magnitude of the windfall loss, and thus reduce employment by more than what is implied by the competitive model. Yet another explanation for the large local employment decline in response to the payroll tax hike (and hence a large inferred labor demand elasticity) is agglomeration spillover effects (see e.g., Ciccone and Hall, 1996; Greenstone et al., 2010) or local multiplier effects (see e.g., Moretti, 2010).[8]

Ultimately, the effectiveness of place-based payroll tax incentives in stimulating local employment depends on how flexibly wages can adjust to a given tax change. In settings where rising labor costs for firms are easily shifted on to worker wages, we would expect no changes in employment levels in response to payroll tax hikes (see e.g., Anderson and Meyer, 1997, 2000; Gruber, 1997). In contrast, in situations where wages cannot fully adjust, employment levels may indeed be responsive to payroll tax changes (see e.g., Kugler and Kugler, 2009; Cruces et al., 2010; Saez et al., 2019). The fact that higher payroll taxes are not fully shifted on to worker wages in our context is indicative of downward wage rigidity in Norway.[9] Overall, our findings suggest that in settings with some degrees of wage rigidity, place-based payroll tax incentives can be effective in stimulating local employment.

By evaluating the impact of geographically differentiated payroll taxes on local wages and employment, we add to the growing literature on place-based policies (see Kline and Moretti, 2014a). Whereas most place-based policies offer a package of programs and incentives (e.g., tax credits together with a block grant) with multitudes of policy objectives, the place-based policy reform evaluated in this paper allows us to isolate the effect of payroll tax incentives in isolation on regional wages and employment. In addition, by proposing a new research design based on an exogenous abolishment of pre-existing and geographically differentiated payroll tax rates faced by firms, we also contribute to the empirical literature that estimates own-wage labor demand elasticities (see Lichter et al., 2015 for an overview).

The rest of the paper is organized as follows. Section 2 explains the policy setting whereas Section 3 presents a theoretical framework to aid the structuring and interpretation of our empirical analysis. Section 4 describes our empirical strategy, and Section 5 presents the data. The results of the empirical analysis, and a discussion of the findings are provided in Section 6. Some concluding comments are provided in Section 7.

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[3] The commuting zones are constructed by Statistics Norway, based on commuting flows of workers between municipalities over the years 2002–2006, rather than on administrative boundaries. See Bhuller (2009) for a documentation of the construction of commuting zones.

[4] Results are also consistent with Stokke (2017) who looks at heterogeneous effects of payroll tax decreases in Norway on employment and wages among workers with different levels of education.

[5] Non-employment here refers to a status where workers are not on unemployment benefits, but at the same time do not have a labor income high enough to support themselves.

[6] This finding is consistent with Dale-Olsen (2018) who shows an increased inflow into disability benefit receipt after a payroll tax hike.

[7] As we show in Section 3, when capital is fixed, the Cobb-Douglas production function implies a labor demand elasticity that is equal to one divided by the capital share in production. That is, assuming a capital share of one third, the implied labor demand elasticity is −3, close to our estimate.

[8] According to this explanation, a reduction in labor demand in some firms spill over to other firms in the local labor market (that thereby also reduce their labor demand) either through a decline in firm productivity or through a decline in the demand for local services in the region.

[9] Wage rigidity due to labor market institutions and collective wage bargaining was also documented in prior research including Saez et al. (2012) and Lehmann et al. (2013) in the contexts of Greece and France, respectively.

2. Background

2.1. The payroll tax harmonization reform

Norway runs a generous social security system to finance pension benefits and health insurance, as well as unemployment, disability and welfare benefits. The system is largely financed through payroll taxes. While employees contribute 8.2% of their gross pay to the scheme, regardless of where they reside, employers' contributions are geographically differentiated. Even though some employers pay significantly more into the system than others, all employees draw the same benefits from the scheme. The motivation behind geographically differentiated payroll taxes is to stimulate employment in more remote areas of the country. Until 2006, Norway was divided into five tax zones, with payroll tax rates ranging from 0% in the northernmost regions to 14.1% in the central areas (see Appendix Fig. A.1). The relevant tax rates faced by a firm were determined by the locations of the workers rather than the location of the firm. This meant that firms located in the same tax zone could face different average tax rates depending on the residency locations of their workers.

In 1999, the European Free Trade Association Surveillance Authority (ESA) ruled that the Norwegian system of geographically differentiated tax rates was not in compliance with trade regulations agreed on by the EU and the European Economic Area (EEA) countries including Norway, Iceland and Lichtenstein. Norway contested the ruling, arguing that the differentiated tax rates (with only minor changes for certain industries) should be considered as *direct transport aid* in line with EU-EEA legislation. ESA approved the proposal, and Norway was allowed to keep the system until 2003.

In September 2002, however, ESA sent a letter to Norwegian authorities requiring that the system had to be changed, and Norway was asked to propose a change by March 25th 2003 that was to be implemented by January 1st 2004.[10] As a result, a tax rate harmonization was imposed between 2004 and 2006. The resulting payroll tax changes in the different zones are illustrated in Fig. 1 (see also Table A.1 in the appendix). Zone 5 (the northernmost region) was allowed to keep its zero payroll tax rate. Zone 1 (central areas) was likewise unaffected, and the payroll tax rate remained constant at 14.1%. In zone 2 the harmonization took place immediately in 2004, raising the tax rate from 10.6% in 2003 to 14.1% in 2004, while the harmonization was more gradual in zones 3 and 4, raising the payroll tax rate by 5.7 and 6.6 percentage points over a three-year period.[11]

The externally imposed harmonization provides an ideal setting to study the impact of payroll tax increases on regional employment and wages, since the changes in the average payroll tax rate faced by firms were imposed by ESA, and are therefore likely to be independent of the local labor market business cycles.

At the same time as complying with the EU ruling of a tax harmonization, the Norwegian government implemented a subsidy scheme to ease the burden (especially on small firms) of the higher payroll taxes introduced in 2004. In particular, firms (in most sectors) could pay the pre-reform (2003) payroll tax rate for the wage bill up to a cap, after which firms would pay the contemporary statutory tax rate for the remaining wage bill. The subsidy is computed at the level of the *firm* (as opposed to the *establishment*); the wage bill therefore refers to the firm's total wage bill across all establishments. The cap was set such

that firms were given a maximum tax relief (subsidy) of 270,000 NOK (38,136 USD) per year.[12] Accordingly, the actual subsidy received by a firm varied over time (as the harmonization proceeded), and depended on the worker composition of the firm. Specifically, the subsidy for firm j in year t is given by

$$S_{j,t} = \min\left\{ \sum_{i=1}^{N_{j,t}} w_{i,t} \times (\tau_{i,t} - \tau_{i,2003}), \overline{S} \right\},$$

where $w_{i,t}$ is the total earnings of worker i employed at this firm in year t, $N_{j,t}$ is the number of workers in firm j (across all establishments) in year t, $\tau_{i,t}$ and $\tau_{i,2003}$ are the post- and pre-reform statutory tax rates relevant for worker i (or her municipality of residence), and $\overline{S}$ is the maximum subsidy. In consequence, in areas that saw an increase in the statutory tax rate, only large firms above a certain size effectively experienced an increase in the payroll tax rate; small firms, on the other hand, were not directly affected by the tax reform. The firm's *effective* tax rate $\tau_{j,t}^{E}$ then is

$$\tau_{j,t}^{E} = \tau_{j,t} - \left(S_{j,t} / \sum_{i=1}^{N_{j,t}} w_{i,t} \right),$$

where $\tau_{j,t}$ is the statutory tax rate, and $\sum_{i=1}^{N_{j,t}} w_{i,t}$ is the firm's total wage bill.

In Fig. 2, we plot the expected effective tax increase from 2003 to 2006 against firms' 2003 wage bills based on the tax schedule shown in Appendix Table A.1. Fig. 2 illustrates, for each tax zone separately, the effective tax increases that firms will experience assuming that each firm recruits all its workers from its own tax zone. As expected, there are no changes in the effective tax rates in zones 1 and 5 (as the reform does not change the statutory tax rates in these zones). For zones 2, 3, and 4, the figure shows that firms below a certain size will not be directly affected by the tax increase whereas the effective tax rate converges towards the statutory tax rate as the wage bill increases and the subsidy becomes negligible. The cutoff point for being exempt from tax increases varies across zones, with the most stringent cutoff (for firms recruiting all their workers from zone 4) corresponding to an annual wage bill of <4.1 million NOK (580,000 USD) in 2003.

2.2. Labor market institutions in Norway

The tax structure and labor market institutions of an economy often go hand in hand (e.g., Summers et al., 1993). In assessing the impact of a place-based payroll tax policy in Norway, it is therefore important to have an understanding of Norway's labor market, and in particular wage setting, institutions. The wage setting in Norway is characterized by centralized bargaining and a high degree of unionization. In 2014, 52% of Norwegian workers were members of a trade union, and close to 70% of workers in the private sector were employed in firms that were members of an employer federation (FAFO, 2014). Even though only firms that belong to an employer federation are legally required to pay union wages, non-member firms often do so as well. The guiding idea behind the wage bargaining system is that the outcome of wage negotiations in the sectors exposed to foreign competition should set the norm for wage growth also in other sectors of the economy. In this way, overall wage growth is linked to productivity growth in the exposed sectors.

In practice, the main federation of trade unions (*Landsorganisasjonen i Norge*) and the main private sector employee federation (*Næringslivets*

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[10] Norway's reply to ESA, 25.03.2003: State aid. Differentiated social security contributions in Norway. https://www.regjeringen.no/no/dokumenter/state-aid-differentiated-social-security-4/id91117/

[11] In 2007, another ESA ruling allowed Norway to re-introduce the system of differentiated payroll taxes (after an appeal case), and tax rates were reduced to their pre-2004 levels. Several other changes to the payroll tax system were made in 2007. First, the statutory tax rate faced by firms was to depend on the location of the firm, as opposed to the location of the workers. Second, some of the municipalities in zones 1 and 4 were classified under two new tax zones: 1a and 4a. Third, there were some changes to the sector exemptions from the system.

[12] All monetary amounts in this paper are converted to USD using the average exchange rate for 2003 where 1 USD = 7.08 NOK.
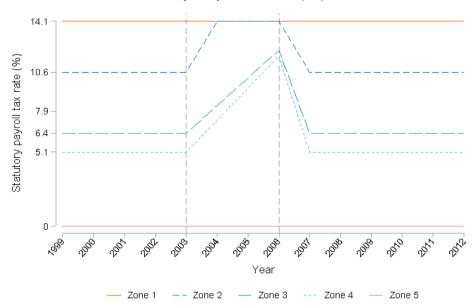
Fig. 1. Statutory payroll tax rates by tax zones (zones 1 to 5). Notes: The table provides an overview of the changes in the statutory payroll tax rates (by tax zone) in Norway imposed by the EFTA Surveillance Authority (ESA). In zones 1 and 5, the tax rates remained unchanged at 14.1% and 0%, respectively. In zone 2, the payroll tax rate increased from 10.6% in 2003 to 14.1% in 2004, and in zones 3 and 4, the tax rates increased by 5.7 and 6.6 percentage points from 2003 to 2006 (see also Table A.1 in the Appendix). In 2007 the geographically differentiated system was re-introduced, after an appeal by Norway on ESA's ruling.
Data sources: The Norwegian Tax Authorities.

Hovedorganisasjon) bargain over wages in the manufacturing sector, based on a common assessment of the economic situation produced by a committee with broad representation. This centralized wage bargaining typically determines a minimum wage increase, while leaving room for local negotiations of supplementary wage increases at the firm level. The local negotiations are supposed to take into account a firm's profitability, productivity, expectations for the future and competitiveness (NOU 2013:13). Despite the manufacturing sector being quite small in Norway, the outcome of the centralized negotiations in this sector has usually served as an effective norm for wage growth both in other private sectors and in the public sector (Kahn, 1998; Gjelsvik et al., 2015).

3. Theoretical framework

A unique aspect of the 2004–2006 reform was the subsidy scheme that rendered large and small firms, operating in the same local labor market, subject to different effective tax rates, even though the region as a whole experienced an increase in the statutory tax rate. This setting gives rise to two main questions with respect to the reform-induced increase in the statutory tax rates: (i) how do overall employment and wages in the region respond? And (ii) do employment and wages adjust differently in large compared to small firms in the region?

To structure our analysis, we outline a benchmark framework of a perfectly competitive labor market where wages can freely adjust to

Fig. 2. Increase in average effective tax rate from 2003 to 2006 over firm size. Notes: The figure plots the expected effective tax increase from 2003 to 2006 against firms' 2003 wage bills, based on the tax schedule shown in Appendix Table A.1. The figure illustrates, for each tax zone separately, the effective tax increases that firms will experience assuming that each firm recruits all its workers from its own tax zone. Firms with an annual wage bill of <4.1 million NOK (580,000 USD) in 2003 were not affected by the tax increase (assuming their work force remained unchanged) regarding of tax zone from which the firm would recruit its workers. The effective tax rate converges towards the statutory tax rate as the firm wage bill increases (and the subsidy becomes negligible).
Data source: Norwegian register data made available by Statistics Norway.

equate supply and demand for labor, and there is one common market-clearing wage among large (subject to tax hikes) and small (exempt from tax hikes) firms operating in the same local labor market. We then consider possible avenues in which the Norwegian setting may depart from the competitive benchmark.

3.1. The competitive benchmark

3.1.1. Production function

Suppose that both types of firms produce output Y by combining labor L and capital according to a Cobb–Douglas production function. Following Glaeser and Gottlieb (2009), we distinguish between two types of capital: capital that is fixed at the firm ($\overline{K}$) and capital that is fully flexible (K). A firm's production function is then given by

$$Y = AL^{\alpha}\overline{K}^{(1-\alpha)(1-\mu)}K^{(1-\alpha)\mu},$$

where μ is the share of fully flexible capital. Assume that all output is sold in international markets at price $p = 1$. Denote by L^D and L^S the labor demand and labor supply, respectively, and w the wage. The statutory payroll tax rate is denoted by τ.

3.1.2. Labor demand

In Appendix A, we outline the behaviour of large and small firms that operate in a given area. Firms choose labor and capital inputs in order to maximize profits. In this setup, we obtain the following labor demand elasticity ε^D:

$$\varepsilon^D = \frac{d\log L^D}{d\log w} = -\frac{1-(1-\alpha)\mu}{(1-\alpha)(1-\mu)} \tag{1}$$

which is increasing (in absolute terms) in the labor's share of output (α), and the share of fully flexible capital (μ).

3.1.3. Labor supply

Let ε^S denote the local labor supply elasticity, $\varepsilon^S = \frac{d\log L^S}{d\log w} \geq 0$. If local labor supply is infinitely elastic ($\varepsilon^S \to \infty$), a slightly higher wage in another local labor market will induce workers to seek employment in that market (leading wages to equalize across local labor markets). If, in contrast, local labor supply is fully inelastic ($\varepsilon^S = 0$; for example because of excessively high moving costs), all workers remain employed in their current local labor market irrespective of the prevailing wage rate in their current relative to other local labor markets. In addition to movements across regions induced by a wage increase, the local labor supply elasticity captures movements into, and out of, employment within the same region.

3.1.4. Equilibrium adjustments

How then do wages in the region respond to an increase in the payroll tax rate in that region? In Appendix A, we show that local wages adjust according to

$$\frac{d\log w}{d\log(1+\tau)} = \frac{\phi\varepsilon^D}{\varepsilon^S - \varepsilon^D} \leq 0 \tag{2}$$

where ϕ denotes the share of workers employed by large firms subject to the tax increase in the local economy. If $\phi = 1$, this expression reduces to the standard expression capturing tax incidence in the literature (see, e.g., Gruber, 1997). In this formulation, full wage shifting—where a 1 percentage point increase in the payroll tax rate leads to a 1% reduction in wages—occurs in the two special cases: either labor supply is fully inelastic ($\varepsilon^S = 0$), or labor demand is infinitely elastic ($\varepsilon^D \to -\infty$). In the more general case where some firms are exempt from the payroll tax hike, the maximum possible wage shifting

(i.e., $\varepsilon^S = 0$ or $\varepsilon^D \to -\infty$), equals $-\phi$, the employment share in firms that are subject to the payroll tax increase.

Since the equilibrium wage falls in response to an increase in the payroll tax rate, small firms that are exempt from the tax increase expand their employment. Denoting the employment in small firms by L^U, we can express the change in L^U to a change in the payroll tax as

$$\frac{d\log L^U}{d\log(1+\tau)} = \varepsilon^D \frac{d\log w}{d\log(1+\tau)} \geq 0 \tag{3}$$

On the other hand, employment in large firms, which we denote by L^A, will shrink following the increase in the payroll tax, as long as the wage decrease is less than proportionate to the tax increase (i.e., $|\frac{d\log w}{d\log(1+\tau)}| < 1$):

$$\frac{d\log L^A}{d\log(1+\tau)} = \varepsilon^D \left(\frac{d\log w}{d\log(1+\tau)} + 1 \right) \leq 0 \tag{4}$$

The expressions (3) and (4) together imply that a payroll tax increase that applies to only some firms in the local labor market will shift employment away from large firms (subject to the tax increase) towards small firms (exempt from the tax increase). Total employment in the local economy L^{total} ($=L^A + L^U$) adjusts according to

$$\frac{d\log L^{total}}{d\log(1+\tau)} = \varepsilon^D \left(\frac{d\log w}{d\log(1+\tau)} + \phi \right) = \varepsilon^D \left(\frac{\phi\varepsilon^S}{\varepsilon^S - \varepsilon^D} \right) \leq 0 \tag{5}$$

The reduction in total regional employment will be more extensive when labor supply is more elastic. If labor supply is infinitely elastic, for instance, total employment shrinks according to $\frac{d\log L^{total}}{d\log(1+\tau)} = \phi\varepsilon^D$, and equilibrium wages remain unchanged. In contrast, if labor supply is completely inelastic ($\varepsilon^S = 0$), an increase in the statutory tax rate leaves total employment unchanged (Eq. (5)), whereas the increased tax will be fully passed on to workers' wages. Furthermore, regional employment will decline more when labor demand is more elastic.

3.2. Possible avenues of departure from the competitive benchmark

The analysis so far has assumed that wages can fully adjust to equate local labor supply to labor demand. The particular wage setting institutions in Norway, however, may render large wage declines in response to tax hikes impossible, and hence wages may be partially downward rigid. The degree of downward wage rigidity plays a similar role in determining the wage and employment responses to the payroll tax increase as magnitude of the labor supply elasticity: The more downward rigid wages are, the more employment will shrink following the payroll tax increase.

When we allow for wage rigidity (and hence no longer maintain market clearing $L^S = L^D$), employment in small and large firms, as well as overall regional employment, will continue to adjust according to Eqs. (3)–(5). What will be different from the competitive case is the wage response. In particular, the wage response to the payroll tax increase ($\frac{d\log w}{d\log(1+\tau)}$) is now determined by the specific wage setting and central bargaining institutions. We will first assess our empirical findings against the competitive benchmark, and then consider the implications of downward wage rigidity.

4. Empirical strategy

The main challenge to evaluating place-based tax incentives, in the form of geographically differentiated payroll taxes, is that the policy is

usually implemented in response to the local economic conditions. This makes it difficult to find a comparable control group to construct a counterfactual outcome – i.e., the outcome in the absence of the place-based policy – for the affected regions. We overcome this challenge by exploiting a setting where the existing place-based policy was suddenly abolished due to an ESA ruling, as described in Section 2.1.

We conduct the analysis at the level of the local labor market, defined as a commuting zone, and compare changes in employment and wages before and after the abolition of geographically differentiated payroll taxes between commuting zones that are differentially exposed to the policy. Norway can be divided into 46 commuting zones or regional labor markets (see Appendix Fig. A.1). We exclude the commuting zone of Oslo from our analysis, as it is far larger and more densely populated than any other commuting zone in Norway, leaving us with 45 commuting zones.[13] Commuting zones are constructed by Statistics Norway and are defined based on commuting flows of workers between municipalities over the years 2002–2006, rather than from administrative boundaries.[14] They thus closely correspond to the concept of a local labor market in Section 3.

Our particular institutional setting provides variation in payroll tax increases across all 45 commuting zones, rather than just across the five large tax zones. First, and most importantly, this is because 23 out of the 45 commuting zones span more than one tax zone. Second, the relevant tax rates are determined by the location of the worker rather than that of the firm or establishment, and commuting zones may differ with respect to their propensity to hire workers from different locations.

4.1. Changes in the statutory tax rate

We start out by constructing a measure of the average statutory tax rate of a commuting zone (ignoring the subsidy scheme), for each of the post-reform years 2004–2006, based on the five tax zones of residency of the workers employed in an establishment located in a commuting zone in the pre-reform year (2003). Since we fix a commuting zone's worker composition to the pre-reform year, the variation in our exposure measure is driven by changes in the statutory payroll tax rates, and not by potentially endogenous changes in the worker composition of a commuting zone.

The predicted average statutory tax rate (hereby "statutory tax rate") in commuting zone c in year t, based on its 2003 worker composition, is given by

$$\hat{\tau}_{c,t} = \sum_{i=1}^{N_{r,2003}} \omega_{i,2003} \times \tau_{z(i,2003),t} \tag{6}$$

where $N_{c,2003}$ denotes the total number of workers employed in in the commuting zone in 2003, and $\tau_{z(i,2003),t}$ denotes the statutory tax rate in year t of the tax zone of residency of worker i in 2003. The time-varying, worker-specific payroll tax rate is weighted by worker i's share in the commuting zone's total wage bill in 2003, i.e., $\omega_{i,2003} \equiv w_{i,2003} / \sum_{j}^{N_{c,2003}} w_{j,2003}$, where $w_{j,2003}$ denotes the wage of worker j in 2003. We then construct a measure of the commuting zone's overall exposure to the tax harmonization policy (over 2004–2006) as follows:

$$\Delta \hat{\tau}_c = \hat{\tau}_{c,2006} - \hat{\tau}_{c,2003}.$$

The regional change in the statutory payroll tax rate, $\Delta \hat{\tau}_c$, varies between 0.03 percentage points (close to a zero change) in Vestfold, a commuting zone located in the south of Norway, and 6.5 percentage

points in Lofoten, a commuting zone located in the north of Norway. Of the total variation in $\Delta \hat{\tau}_r$ across 45 commuting zones, 84% is across, and 16% within, tax zones.

4.2. Event study

To visualize the evolution of outcomes (employment and wages) in local labor markets experiencing a large (versus small) change in tax rates, we start our empirical analysis by conducting an event study. In particular, we split the commuting zones in our sample into two groups based on their overall exposure:

$$T_c = \begin{cases} 1 \ if \ \Delta \hat{\tau}_c \geq 4 \ pp, \\ 0 \ if \ \Delta \hat{\tau}_c < 4 \ pp. \end{cases} \tag{7}$$

We designate commuting zones with $T_c = 1$ as "treated" (11 commuting zones) and those with $T_c = 0$ as "controls" (34 commuting zones). The cut-off of four percentage points is arbitrary and is chosen to ensure that the "treated" commuting zones experience a significant tax increase. The key conclusions of our paper do not hinge on the specific cut-off chosen. We compare employment and wages in "treated" and "control" commuting zones in the years prior to and following the tax reform using 2003 as the reference year. The event study allows us to assess whether the two types of commuting zones experienced similar time trends in employment and wages prior to the 2003 reform, but diverge afterwards.[15]

In a regression framework, our event study corresponds to estimating the following difference-in-differences equation:

$$\ln(y_{c,t}) = \lambda \, T_c + \rho_t \times \boldsymbol{S}_c + \sum_{\kappa \neq 2003} \gamma_\kappa T_c \times I(t = \kappa) + v_{c,t}, \tag{8}$$

where $y_{c,t}$ is the outcome variable of interest (i.e., employment and wages) in commuting zone c in year t; T_c indicates the treatment status as defined in Eq. (7); ρ_t denote year fixed effects; and $\boldsymbol{S}_c$ is a vector of regional industry shares (the share of workers in the commuting zone in 2003 employed in 11 different industries).[16] The coefficients γ_κ show the dynamic effects of the payroll tax increases on local outcomes. Instead of imposing common year effects across regions, this specification allows the year fixed effects to differ by the commuting zone's industry structure (through the interaction between ρ_t and $\boldsymbol{S}_c$). In the absence of differential pre-existing trends between treated and control commuting zones (unaccounted for by differences in the commuting zone's industry structure), the coefficients γ_κ should be close to zero for years prior to the tax reform (i.e., $\kappa < 2003$). For the post-reform years, the coefficients γ_κ reveal the dynamic impact of the payroll tax increase on regional outcomes.

4.3. Baseline regression equations

In our main analysis, we exploit the variation in the statutory tax rates over time and across commuting zones more fully, and estimate the following regression:

$$\ln(y_{c,t}) = \beta \, \ln(1 + \hat{\tau}_{c,t}) + \delta_c + \rho_t \times \boldsymbol{S}_c + \varepsilon_{c,t}, \tag{9}$$

where $\hat{\tau}_{c,t}$ is the (predicted) statutory tax rate based on the commuting zone's worker composition in 2003, as defined in Eq. (6); δ_c denotes commuting zone fixed effects; and $\varepsilon_{c,t}$ is an error term. As in Eq. (8),

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[13] Because of its large size, Oslo would receive a very large weight in the employment-weighted regional regressions. In unweighted regional regressions, including Oslo in the sample has little impact on our estimates. Estimates from employment-weighted and unweighted regressions are similar in magnitude once Oslo is excluded from the sample.

[14] See Bhuller (2009) for a documentation of the construction of commuting zones.

[15] Like any spatial difference-in-difference designs, we cannot account for general equilibrium effects that may arise from a variety of channels including trade between regions, costs of living, agglomeration, public good provision, etc. For a full-fledged spatial equilibrium model, see Fajgelbaum et al. (2019).

[16] We use 11 industries defined based on establishment NACE codes. The 11 industries are listed in Table 1.

we include year fixed effects ρ_t interacted with a vector of regional initial industry shares $\boldsymbol{S}_c$.

In regression Eq. (9), the parameter of interest, β, measures the impact of a one percent increase in $(1 + \hat{\tau}_{c,t})$—which approximately corresponds to a one percentage point increase in the statutory tax rate—on (log) wages and total employment in the commuting zone. The theoretical counterpart to the estimates of β for wages and employment are given by Eqs. (2) and (5) respectively, which are functions of the share of workers employed in exempt firms, ϕ, and the labor supply and labor demand elasticities, ε^D and ε^S. When estimating regression Eqs. (8) and (9), we weight by the number of employees in the commuting zone in 2003, and cluster standard errors at the level of the commuting zone.

4.3.1. Large versus small firms

Because of the subsidy scheme described in Section 2.1, the same change in the statutory tax rate leads to differential changes in effective tax rates for large and small firms that are located in the same commuting zone. Therefore, to shed light on their differential adjustment behavior, we estimate Eqs. (8) and (9) separately for the two types of firms. We classify firms into large versus small based on whether or not their wage bill falls above or below the cutoff point of 4.1 million NOK, as defined in Fig. 2.[17] To be precise, as the same firm may have establishments in different commuting zones, we investigate whether the payroll tax hike differentially affects employment in establishments that are part of a large (above the subsidy cut-off) or small (below the subsidy cut-off) firm.

5. Data

Our analyses make use of several sources of administrative register data, provided by Statistics Norway that can be linked through unique firm, establishment and worker identifiers. The main data source is the linked employer-employee register that covers all employment spells for the period 2000 to 2006. The data set includes information on the number of days a worker worked during the year, her wage, the dates when she started and stopped working for a particular establishment, the establishment and firm identification number, as well as the establishment's and firm's location (municipality) and sector affiliation. We match these data to data on worker demographics, including education, labor market experience, age, gender and country of origin. We further make use of a longitudinal database with information on workers' municipality of residence. Finally, to study flows from regional private sector employment to other types of employment such as self-employment not registered in the employer-employee register (in the analysis in Section 6.4), we make use of data on earnings from the tax records.

From the employer-employee register, we select all firms (and their workers) in the private sector outside the commuting zone of Oslo. We exclude firms in the public sector as they may not choose inputs to maximize profits. We drop workers with missing information on the municipality of residence or the municipality of their establishment. Overall, our sample includes 880,812 unique workers.

Table 1 compares treated community zones that faced an increase in the statutory payroll tax rate of at least 4 percentage points from 2003 to 2006, and control community zones that experienced an increase of <4 percentage points. In 2003, the statutory payroll tax rate was, on average, 6.0% in treated areas, and 11.6% in control areas. Treated community zones experienced a 5.9 percentage point increase in the statutory tax rate on average, compared to a 1 percentage point increase in control community zones, harmonizing the payroll tax rate in treated

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[17] For firms that exist in the year prior to the reform (2003), we use the firm's total wage bill in 2003. For firms that do not exist in 2003 but existed in prior years, we use the firm's total wage bill in the last year of existence. If the firm enters only after the reform, we use the firm's wage bill in the first year of entry.

Table 1
Descriptive statistics: treated vs control commuting zones.
Data source: Norwegian register data made available by Statistics Norway.

	(1)	(2)
	Treated (large statutory tax increase)	Control (zero/small statutory tax increase)
Statutory tax rate 2003	0.060	0.117
Change in stat. tax rate 03–06	0.059	0.010
Daily wages	657.887	707.592
Workers	8938.857	24,376.387
Industries		
Agriculture/oil/mining	0.049	0.039
Manufacturing	0.218	0.287
Construction	0.117	0.106
Wholesale	0.087	0.089
Retail	0.156	0.141
Hotel/restaurants/catering	0.062	0.053
Transport	0.129	0.099
Insurance/property mng.	0.027	0.033
Finance	0.006	0.011
Health	0.049	0.040
Other	0.105	0.112
Number of commuting zones	14	31

Notes: The table compares treated commuting zones that experienced an increase in the statutory payroll tax rate of at least four percentage points, and control commuting zones that experienced an increase in the statutory payroll tax rate of less than four percentage points (see Section 4.2 and Eq. (7)) in terms of the statutory tax rate in 2003, the increase in the statutory tax rate between 2003 and 2006, the number of employed workers in 2003, the daily wage in 2003, and the sector structure in 2003. Monetary amounts are given in NOK (1 USD = 7.08 NOK in 2003). The total number of unique workers is 880,812.

and control areas. As expected, treated commuting zones employ fewer workers than control community zones. Wages are slightly higher in control than in treated commuting zones. The construction sector is overrepresented, whereas the finance sector is underrepresented, in treated relative to control commuting zones.

It should be noted that our empirical approach accounts for any time-constant differences between treated and control areas through the inclusion of commuting zone fixed effects. Moreover, we include regional (pre-reform) industry shares interacted with year effects, thereby accounting for the possibility that commuting zones experience different time trends because of differences in their industry structure. The event study provides further visual evidence that the two types of commuting zones experienced similar trends in total employment and wages prior to the 2003 tax reform, but start to diverge afterwards.

6. Results

6.1. Overall regional employment and wage effects of payroll tax hikes
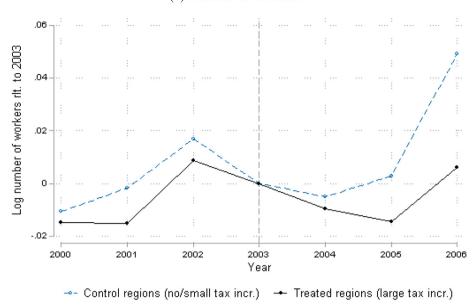
6.1.1. Event study

In a first step, we simply plot the evolution of total regional employment (in logs) and average regional wages (in logs) separately for treated and control commuting zones over the period from 2000 to 2006, the years prior to and three years after the payroll tax hike (Fig. 3). Panel (a) highlights that total regional employment increased at a roughly similar pace in the two types of commuting zones in the years prior to the reform. After the reform, regional employment first declined at a higher rate, and then increased at a lower rate, in treated than in control commuting zones, in line with the hypothesis that the payroll tax hike caused a decline in regional employment. Turning to regional wages, panel (b) of Fig. 3 shows that wages grew by roughly 4% per year in both treated and commuting zones, both before and after the tax reform, suggesting that the reform did not have a large impact on regional wages.

In Fig. 4, we display the coefficients γ_k from the event study regression Eq. (8) that trace out regional employment in treated commuting zones *relative to* control commuting zones, and allow the year fixed effects to differ by the commuting zone's industry structure. In line with

(a) Number of Workers
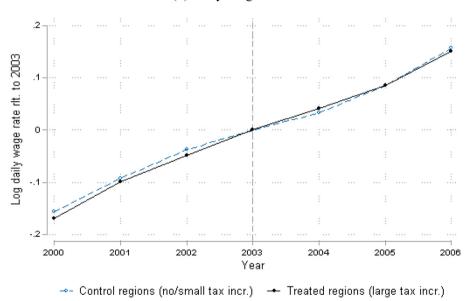

(b) Daily Wage Rate

Fig. 3. Raw means of employment and wages over time: treatment versus control commuting zones. Notes: The figures show the time series of log number of workers (panel (a)) and log daily wage rate (panel (b)) in treated (black dashed line) and control (blue line) commuting zones. Means are weighted by the number of workers in the commuting zone in 2003. Treated/control commuting zones are defined as commuting zones that experienced an increase in the average statutory payroll tax rate in the commuting zone of at least/less than four percentage points (see Section 4.2 and Eq. (7)). The vertical line indicates the point in time in which the increases in the payroll tax rates came into effect. There are 45 commuting zones (labor market regions), of which 11 are statutory treated and 34 are statutory control regions. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)
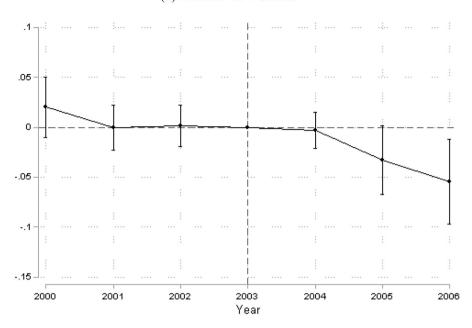Data source: Norwegian register data made available by Statistics Norway.

Fig. 3, total regional employment evolved similarly in treated and control commuting zones prior to the tax hike, but sharply declines in treated relative to control commuting zones sharply thereafter—by about 6% three years after the tax hike (panel (a)). Regional wages, in contrast, develop at a similar pace in treated and control commuting zones not only prior to, but also after, the payroll tax hike (panel (b)).

6.1.2. Regression analyses

6.1.2.1. Baseline estimates. We next exploit the variation in the statutory tax rates over time and across workers more fully, by estimating

Eq. (9) for the commuting zone as a whole. We report the estimated coefficients in Table 2 along with a number of robustness checks. The results confirm the findings of a reduction in employment from the event study. A one percentage point increase in the statutory tax rate reduces total regional employment by 1.37% (panel (a)). This estimate is of similar magnitude as that implied by the event study in Fig. 4. According to the figure, treated commuting zones experience a 6% decline in local employment and a 4.9 percentage point increase in the statutory tax rate relative to control commuting zones, implying a 1.22% (0.06/0.049) decline in employment for an increase in the statutory tax rate of 1 percentage point. For wages, we find that a 1
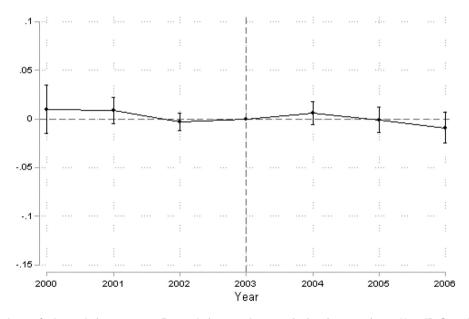
(a) Number of Workers

(b) Daily Wage Rate

Fig. 4. Event study estimates of the impact of an increase in the statutory payroll tax rate in the commuting zone on local employment and wages. Notes: The figure plots the estimated coefficients and standard errors on interacted year and treatment fixed effects in the regressions of log number of workers in a region (panel (a)), and log average daily wage rate among workers in a commuting zone (panel (b)) on year and treatment fixed effects, as well as their interactions. The regressions further include commuting zone sector shares interacted with year dummy variables (Eq. (8)). Treated/control regions are defined as commuting zones that experienced an increase in the regional statutory payroll tax rate of at least/less than four percentage points. The regressions are weighted by the number of workers in the commuting zone in 2003, and standard errors are clustered at the regional level. The vertical line indicates the point in time when the increases in the payroll tax rates came into effect. There are 45 commuting zones (labor market regions), of which 11 are statutory treated and 34 are statutory control regions. Data source: Norwegian register data made available by Statistics Norway.

percentage point increase in the statutory tax rate leads to a decrease in the regional wages by 0.32% (albeit estimated with little statistical precision).[18]

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[18] We present the reduced-form estimates throughout, using the predicted regional statutory tax rate (calculated based on 2003 worker composition) as the main regressor. When we use the actual regional statutory tax rate (based on contemporary worker composition) as the main regressor and instrument it by the predicted regional statutory tax rate, the IV estimates are very close to the reduced-form estimates. See Appendix Table A.2.

6.1.2.2. Robustness checks. The tax reform was implemented the same year as the 2004 expansion of the EU, and we might therefore worry that the inflow of labor from Eastern Europe affected treated and control commuting zones differently. To assess this, we restrict the sample to Norwegian-born workers (panel (B) of Table 2). The results from this robustness exercise are similar to the baseline results.

Second, ESA allowed Norway to keep a zero tax rate in zone 5, the most remote and sparsely populated region. Results are not sensitive

Table 2

Effects of statutory payroll tax rates on local employment and wages.
Data source: Norwegian register data made available by Statistics Norway.

	(1) Employment	(2) Daily wage rate
(A) Baseline		
Statutory tax rate	−1.372**	−0.320
	(0.640)	(0.195)
Obs. (no. of commuting zones X years)	315	315
(B) Norwegian-born workers		
Statutory tax rate	−1.183**	−0.311*
	(0.547)	(0.186)
Obs. (no. of commuting zones X years)	315	315
(C) Excluding establishments in zone 5		
Statutory tax rate	−1.784***	−0.401*
	(0.681)	(0.234)
Obs. (no. of commuting zones X years)	294	294
(D) 2001 worker composition		
Statutory tax rate	−1.127*	−0.314
	(0.650)	(0.204)
Obs. (no. of commuting zones X years)	315	315

Notes: The table reports baseline estimates, and various robustness checks, for the effects on a one percentage point increase in the predicted statutory payroll tax on the number of workers (in logs) and the daily wage rate (in logs) in the commuting zone. Panel (A) shows the baseline results for all workers in establishments in the commuting zone; panel (B) shows results restricting the sample to Norwegian-born workers (excluding 10% of the observations); panel (C) shows results when excluding workers in establishments located in the most remote tax zone 5 that was unaffected by the payroll tax reform (excluding 2.2% of the observations); and panel (D) shows results when the commuting zone worker composition in 2001 (rather than 2003) is used to construct the average statutory payroll tax rate in the commuting zone. All results are obtained from regressions at the level of the commuting zone of the outcome variables on $\log(1 +$ statutory tax rate), where the average statutory tax rate in the commuting zone is defined in Eq. (6). Regressions additionally include controls for year and commuting zone fixed effects, as well as commuting zone sector shares in 2003 interacted with year dummy variables (as in Eq. (9)). The regressions in panels (A)–(C) are weighted by the number of workers in the commuting zone in 2003, and the regressions in panel (D) are weighted by the number of workers in the commuting zone in 2001. Standard errors are clustered at the level of the commuting zone. There are 45 commuting zones (labor market regions), of which 11 are statutory treated and 34 are statutory control regions.

   * $p < 0.1$.
  ** $p < 0.05$.
 *** $p < 0.01$.

to excluding commuting zones (partly) located in tax zone 5 (panel (C) of Table 2).

Third, our results so far compute the firm's average statutory tax rate based on its 2003 workforce composition—before the tax change came into effect in 2004. Although the extent and timing of the EU-induced tax changes were not laid out until March 2003, anticipatory adjustments to the 2003 tax reform are possible, as firms knew as of September 2002 that some changes would have to be made. Our results are robust to using 2001 workforce composition of commuting zones to calculate average regional statutory tax rates (panel (D) of Table 2).

6.2. Differential adjustments by large versus small firms

So far, we have examined the effect of changes in the statutory tax rate on the employment and wage levels in the region overall. Next, we examine possibly differential effects of the statutory tax hikes on establishments that are part of a large (subject to tax hikes) or small (exempt from tax hikes due to subsidy) firm. For simplicity, we refer to the two types of establishments as large and small establishments (even though the classification large versus small was done at the level of the firm).

In Fig. 5, we present an event study based on regression Eq. (8), separately for the two types of establishments in the commuting zone. The figure shows that the decline in employment in treated relative to control commuting zones after the tax hike is much more pronounced in large establishments subject to the payroll tax increase (panel (a)) than in small exempt establishments (panel (b)). The differential

employment responses in small and large establishments provide reassurance that the drop in total regional employment is indeed caused by the tax reform, and not by differential macroeconomic conditions in remote and central regions. The figure further shows that wages evolved similarly in treated and control regions in both large and small establishments (panels (c) and (d))—as we would expect if a single market wage applies to all establishments in the commuting zone.

Table 3 presents employment and wage effects (estimates based on Eq. (9)) separately for large and small establishments. An increase in the statutory tax rate by one percentage point reduces regional employment in large establishments by 1.28% (panel (a)). The regional employment effect in small establishments is imprecisely estimated but indicates a lower reduction of −0.56%.

While the theoretical framework presented in Section 3 predicts a non-negative employment effect among small, exempt establishments, there are two main explanations for why we might find a negative effect. First, since we classify firms and establishments as large versus small status based on their pre-reform wage bill, some establishments classified as small might in practice become large in subsequent years and hence are subject to the payroll tax increase. In fact, 20% of the establishments classified as small become large in the sense that their wage bill (or the wage bill of the firm that they belong to) exceeds the cut-off of 4.1 million NOK at some point during the years 2004–2006. Second, the negative employment effect in small establishments may be due to agglomeration spillover effects, whereby the reduced economic activity in the commuting zone lowers the productivity of local establishments (e.g., Ciccone and Hall, 1996; Greenstone et al., 2010), or local multiplier effects whereby the reduced economic activity in the commuting zone lessens the demand for local services (e.g., Moretti, 2010).

6.3. Heterogeneity analysis

Our theoretical framework in Section 3 highlights that the employment reduction in large establishments is increasing in the labor demand elasticity (Eq. (4)), which in turn is higher in labor-intensive (high α) than in capital-intensive firms (Eq. (1)). In Table 4, we show results that are in line with this prediction. The table shows estimates of β in regression Eq. (9) among establishments that are part of a large firm, separately for labor-intensive (column (1)) and non-labor-intensive (column (2)) establishments.[19] The results show that the drop is considerably larger in labor-intensive than in non-labor-intensive establishments, in line with the theoretical framework.

Further, we examine effect heterogeneity by firm size while continuing to focus on the sample of establishments that are part of large (above the subsidy cut-off) firms. This split is motivated by the fact that larger firms further away from the subsidy cut-off will experience a larger increase in their total labor costs (for their stock of incumbent workers) than smaller firms close to the subsidy cut-off, while the marginal cost of hiring a new worker increases in the same way for all firms. To explore this idea, we split establishments (that are part of large firms and hence subject to the tax increases) into three groups. The first group accounts for 25% of the workers in the sample, namely those employed in the smallest firms closest to the subsidy cut-off. The second group accounts for 50% of the workers in the sample, namely those employed in medium-sized large firms. The third group accounts for 25% of the workers in the sample, namely those employed in the largest firms

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[19] We use the definition of labor intensive sectors from a governmental report (St.mld. nr. 41, 1998). The labor intensive sectors are as follows: Manufacture of food and fish products; manufacture of wood and wood products; graphic production; manufacture of ceramic products; manufacture of basic metal and fabricated metal products; manufacture of machinery and equipment; manufacture of electrical and optical equipment; transport; other industry production; wholesale; construction; and hotels and restaurants and business activities.

(a) Log Number of Workers

Large Establishments

Small Establishments

(b) Log Daily Wage Rate

Large Establishments

Small Establishments

Fig. 5. Event study estimates: large versus small establishments. Notes: The figure plots the estimated coefficients and standard errors on interacted year and treatment fixed effects in the regressions of log number of workers in a region (panel (a)), and log average daily wage rate among workers in a commuting zone (panel (b)) on year and treatment fixed effects, as well as their interactions. The regressions further include commuting zone sector shares interacted with year dummy variables (Eq. (8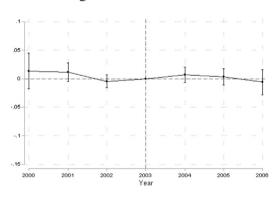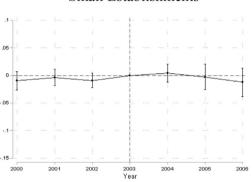)). Regressions are estimated separately for establishments that are part of a large firm (subject to the tax increases) and establishments that are part of a small firm (exempt from the tax increases). Treated/control commuting zones are defined as commuting zones that experienced an increase in the average payroll tax rate in the commuting zones of at least/less than four percentage points. The regressions are weighted by the number of workers in large or in small establishments in the commuting zones in 2003, and standard errors are clustered at the level of the commuting zones. The vertical line indicates the point in time in which the increases in the payroll tax rates came into effect. There are 45 commuting zones (labor market regions), of which 11 are statutory treated and 34 are statutory control regions.
Data source: Norwegian register data made available by Statistics Norway.

furthest away from the subsidy cut-off. Comparing columns (3) and (4), we find that a payroll tax hike leads to a stronger employment decline in establishments that are part of a medium-sized large firm further away from the subsidy cut-off than in establishments that are part of a smaller large firm close to the subsidy cut-off. In establishments that belong to the largest firms (column (5)), employment does not decrease in response to a payroll tax increase, although the employment response is imprecisely estimated. These very large firms may have sufficient means to cushion the labor cost shock (e.g., by increasing product prices or through lower profits).

6.4. Mechanisms of regional employment adjustment

In this section, we shed some light on the various margins of adjustments that can explain the regional employment drop. In panel (a) of

Fig. 6, we decompose the overall decline in regional employment in treated relative to control commuting zones three years after the tax reform into reductions in regional employment that are due to reduced inflow into employment and increased outflows out of employment:

$$\underbrace{\frac{E_{2006} - E_{2003}}{E_{2003}}}_{\text{Total change in employment}} = \underbrace{\frac{N_{inflows_{2006}}}{E_{2003}}}_{\text{inflows}} - \underbrace{\frac{N_{outflows_{2006}}}{E_{2003}}}_{\text{outflows}}$$

Inflows are composed of workers who enter into regional private sector employment from other regions, from unemployment, from non-employment, or from the public sector or self-employment. Outflows consist of workers who leave regional private sector employment and move to other regions, or who transition into the public sector or self-employment, unemployment or non-labor force participation within the region. We estimate regression Eq. (8) using total employment as well as inflows and outflows as

dependent variables. Panel (a) of Fig. 6 shows that the drop in regional employment following a tax hike is entirely accounted for by an increase in outflows from the commuting zones (the gray bar); inflows to the commuting zone in fact increases slightly after the tax hike (the mint-green bar).

In panel (b) of the figure, we decompose the overall employment drop in the commuting zone in response to the payroll tax increase into jobs lost due to increased establishment exit, reduced establishment entry and employment adjustments at the intensive margin, within continuing establishments:

$$\underbrace{\frac{E_{2006}-E_{2003}}{E_{2003}}}_{\text{Total change in employment}} = \underbrace{\frac{N_{entry_{2006}}}{E_{2003}}}_{\text{establishment entry}} - \underbrace{\frac{N_{exit_{2006}}}{E_{2003}}}_{\text{establishment exit}}$$

$$+ \underbrace{\frac{N_{hires_{2006}}}{E_{2003}} - \frac{N_{separations_{2006}}}{E_{2003}}}_{\text{continuing establishments}}$$

Establishment exit between year 2003 and 2006 is defined as the establishment identification number existing in 2003, but not in 2006. Establishment entry is defined as the establishment identification number existing in 2006, but not in 2003. The findings in panel (b) of Fig. 6 show that increased establishment exit (the brown bar) is an important margin of adjustment, accounting for a bit more than a third of the overall employment decline in the region, while establishment entry has a negligible impact on employment. Employment adjustments within continuing establishments (the orange bar) make up a bit less than two thirds of the overall employment drop in the commuting zone following the payroll tax hike.

Finally, the findings in panel (c) of Fig. 6 shed light on whether the employment drop in treated relative to control commuting zones in response to the payroll tax increase represents a reallocation of workers across commuting zones, an increase in un- or non-employment within the commuting zone, or an increase in other types of employment (public sector employment or self-employment) within the commuting zone.[20]

$$\underbrace{\frac{E_{2006}-E_{2003}}{E_{2003}}}_{\text{Total change in employment}} = \underbrace{\frac{Inflow_{region_{2006}}-Outflow_{region}}{E_{2003}}}_{\text{employment moves across regions}}$$

$$+ \underbrace{\frac{Inflow_{unemp_{2006}}-Outflow_{unemp}}{E_{2003}}}_{\text{moves into and from unemployment}}$$

$$+ \underbrace{\frac{Inflow_{otheremp_{2006}}-Outflow_{otheremp}}{E_{2003}}}_{\text{moves into and from other types of employment}}$$

$$+ \underbrace{\frac{Inflow_{non\text{-}emp_{2006}}-Outflow_{non\text{-}emp}}{E_{2003}}}_{\text{moves into and from non-employment}}$$

The figure shows that movements from or into other commuting zones make up only a small share of the overall drop in regional employment (7%, the green bar). This may reflect the low regional mobility in Norway—only 7.5% of workers in our sample are employed in a different commuting zone in 2006 from that in 2003. The other three components are of roughly equal importance. Around 30% of the overall

Table 3

Effects of statutory payroll tax rates on employment and wages in large and small establishments.
Data source: Norwegian register data made available by Statistics Norway.

	(1)	(2)
	Large establishments	Small establishments
(A) Employment		
Statutory tax rate	−1.288[*]	−0.561
	(0.671)	(0.655)
(B) Daily wage rate		
Statutory tax rate	−0.292	−0.196
	(0.216)	(0.279)
No. of establishments	12,162	112,531
No. unique workers	895,168	468,980
Obs. (no. of commuting zones X years)	315	315

Notes: The table shows estimates for the effects of a one percentage point increase in the predicted statutory payroll tax rate (as defined in Eq. (6)) on employment (in logs, panel (A)) and daily wages (in logs, panel (B)) in the commuting zone, separately for establishments that are part of a large firm (subject to the payroll tax increase) and establishments that are part of a small firm (exempt from the payroll tax increase). All results are obtained from regressions at the level of the commuting zone of the outcome variables on $\log(1 + \text{statutory tax rate})$, where the average statutory tax rate in the commuting zone is defined in Eq. (6). Regressions additionally include controls for year and commuting zone fixed effects, as well as commuting zone sector shares in 2003 interacted with year dummy variables (as in Eq. (9)). Regressions are weighted by the number of workers in large and small establishments in the commuting zone in 2003. Standard errors are clustered at the level of the commuting zone. There are 45 commuting zones (labor market regions), of which 11 are statutory treated and 34 are statutory control regions.
[*] $p < 0.1$.
[**] $p < 0.05$.
[***] $p < 0.01$.

regional employment drop is accounted for by moves into and out of unemployment (the pink bar), while movements into and out of non-employment make up 35% of the overall regional employment drop (the darker blue bar). About 28% of the overall regional employment drop is due to transitions into other types of employment within the region (the light blue bar).

6.5. Discussion

What do our findings imply for the pass-through of payroll taxes on wages? While the wage response to the payroll tax hike is imprecisely estimated, our baseline estimate implies a 0.32% decline in wages in response to a 1 percentage point increase in the payroll tax rate (panel (A) of Table 2). Since not all firms are subject to the payroll tax increase, full wage shifting (which occurs either if labor supply is completely inelastic or labor demand is infinitely elastic) in our context implies a wage response of −0.7, equal to the employment share ϕ in firms subject to the tax increase (see Eq. (2)). Benchmarked against this number, our estimate of −0.320 implies that we can reject the null hypothesis of a full pass through (i.e., $\beta \geq -0.7$) at the conventional level of statistical significance.[21] Instead, our estimated wage response indicates a pass-through rate of 0.46% (0.32/0.7), a rate that is comparable to that found in Holmlund (1983) and Johansen and Klette (1997) for earlier periods in Sweden and Norway. In contrast, Gruber (1997) and Anderson and Meyer (1997) find evidence for full pass-through in the context of Chile and the US where the degree of unionization is low and wages may thus be more downward flexible.[22]

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[20] The variable "Other employment" is a proxy, based on tax records, for other types of employment, including sole-proprietorship and public sector work. An individual is defined as being in this category if the sum of wage and net business income exceeds two times the Basic Amount (BA) in the Pension System (1 BA = 56,861 (8.028 USD) in year 2003).

[21] The t-statistic is $\frac{-0.320-(-0.7)}{0.195} = -1.948$, which is associated with a *p*-value of 0.026.
[22] As of 2000, 13.2% and 12.9% of workers are unionized in Chile and the US, respectively (https://stats.oecd.org/Index.aspx?DataSetCode=TUD). The corresponding figure for Norway and Sweden are 54.1% and 80.1%, respectively.

Table 4

Heterogeneous effects by labor intensity and establishment size.

Data source: Norwegian register data made available by Statistics Norway.

	(1)	(2)	(3)	(4)	(5)
	By labor intensity		*By firm size*		
	Labor-intensive establishments	Non-labor intensive establishments	Establishments <25th pct.	Establishments 25th–75th pct.	Establishments >75th pct.
Statutory tax rate	−1.213**	−0.394	−0.724	−2.645***	0.651
	(0.584)	(0.502)	(1.144)	(0.962)	(2.393)
No. of establishments	6254	5908	8289	3711	162
No. unique workers	434,110	576,111	261,561	499,066	249,594
No. of commuting zones X years	315	315	315	315	315

Notes: The table shows estimates for the effects of a one percentage point increase in the predicted statutory payroll tax rate (as defined in Eq. (6)) on employment (in logs, panel (A)) and daily wages (in logs, panel (B)) in the commuting zone, separately by labor intensity (columns (1) and (2)) and firm size (columns (3) to (5)). The sample is restricted to establishments that are part of a large firm (subject to the tax increase). All results are obtained from regressions at the level of the commuting zone of the outcome variables on log(1 + statutory tax rate), where the average statutory tax rate in the commuting zone is defined in Eq. (6). Regressions additionally include controls for year and commuting zone fixed effects, as well as commuting zone sector shares in 2003 interacted with year dummy variables (as in Eq. (9)). We split establishments into two groups based on the labor intensity of the sector they operate in. We divide establishments into three groups based on the size of the firm they belong to. The first group accounts for 25% of the workers in the sample, namely those employed in the smallest firms closest to the subsidy cut-off. The second group accounts for 50% of the workers in the sample, namely those employed in medium-sized large firms. The third group accounts for 25% of the workers in the sample, namely those employed in the largest firms furthest away from the subsidy cut-off. Regressions are weighted by the number of workers in the commuting zone in 2003. Standard errors are clustered at the level of the commuting zone. There are 45 commuting zones (labor market regions), of which 11 are statutory treated and 34 are statutory control regions.

* $p < 0.1$.

** $p < 0.05$.

*** $p < 0.01$.

We can also use our estimated wage and employment responses to the payroll tax hike, in combination with the theoretical framework, to back out the labor supply and labor demand elasticities. When viewed through the lens of the perfectly competitive model outlined in Section 3.1 (Eqs. (2) and (5)), our baseline estimates of −0.32% for the wage response and −1.37% for the employment response (panel (A) of Table 2), together with $\phi = 0.7$ imply a labor supply elasticity of $\varepsilon^S = 4.28$ and a labor demand elasticity of $\varepsilon^D = -3.60$.

The implied labor supply elasticity is considerably larger than that found in studies that focus on the combination of intensive (hours worked) and extensive (employment) margins, and that generally find elasticities well below 1 (see Blundell and MaCurdy, 1999; Chetty et al., 2011; Chetty, 2012). Our context is different, however, since the labor supply elasticity measures the (percentage) decline in *private sector* employment in the *commuting zone* in response to a 1% decline in the local wage, and hence also captures movements across commuting zones, as well as movements to and from the private sector to other forms of employment (i.e., public sector employment and self-employment) within the commuting zone. Whereas the former account, due to the low regional mobility in Norway, only for a small part of the overall regional employment response, the latter explain 28% of the overall regional employment response (Fig. 6). One possible interpretation of the large estimate for the labor supply elasticity therefore is that labor is highly elastic between the private sector employment and other forms of employment within the same region.[23]

An alternative, and in our view, more likely explanation for the large implied (by the fully competitive model) elasticity of labor supply, given that two thirds of the overall regional employment decline is accounted for by movements from and into un- and non-employment, is that the high degree of centralized bargaining and unionization in Norway prevent large downward wage adjustments to payroll tax hikes.[24] The lower pass-through rate compared to that found in countries with a lower degree of unionization is in line with this explanation.

Our estimate for the labor demand elasticity of −3.6 falls in the upper range of estimates reported in the literature (see Lichter et al.,

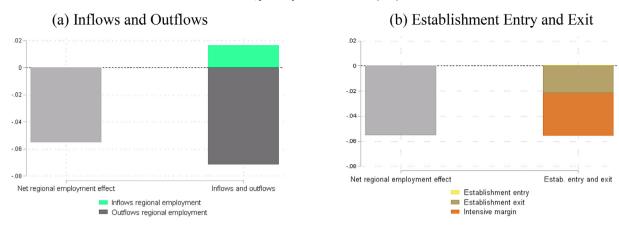2015 for a meta study). One possible explanation for such a large labor demand elasticity is that capital is fixed over the three-year study period. According to Eq. (1), assuming that capital is fully fixed ($\mu = 0$) and a labor share of two thirds ($\alpha = 2/3$), the Cobb–Douglas production function implies a labor demand elasticity of $-\frac{1}{1-\alpha} = -3$, which is close to our estimate of −3.6.

An alternative explanation for the high labor demand elasticity is based on liquidity constraints, as recently put forward by Saez et al. (2019) (see also Melcangi, 2018). The idea here is that liquidity-constrained firms faced with an unexpected windfall loss (in our context caused by a payroll tax hike) may be forced to bring down labor costs quickly to lessen the magnitude of the windfall loss, and thus reduce employment (by more than what is implied by the competitive model). Our findings in Table 4 are in principle consistent with this interpretation. The findings in Table 4 show that employment declines less in firms close to the subsidy cut-off than in larger (but not extremely large) firms further away from the subsidy cut-off. Both types of firms experience an increase in the marginal cost of hiring a new worker. Larger firms, however, suffer a larger windfall loss, as labor costs increased not only for newly hired workers, but also for their existing workforce.

The large decline in local employment in response to the payroll tax hike (and hence the large inferred labor demand elasticity) could also be a consequence of agglomeration spillover (e.g., Ciccone and Hall, 1996; Greenstone et al., 2010) and local multiplier effects (e.g., Moretti, 2010).[25] According to this explanation, a reduction in labor demand in some firms create a domino effect in the local labor market, triggering additional employment reductions in other firms, either through a decline in firm productivity or through a decline in the demand for local services in the region. Our finding of a negative (though imprecisely estimated) employment effect in small firms that are exempt from the payroll tax hike is in line with this explanation.

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[23] This argument rests on the assumption that wages in the public and self-employed sector did not decline by as much as wages in the private sector in response to the payroll tax hike.

[24] In this case, it is not possible to obtain an estimate for the labor supply elasticity.

[25] The simple model in Section 3 ignores agglomeration and local multiplier effects, and attributes the local employment response to the payroll tax hike, given the wage response, entirely to the labor demand elasticity.
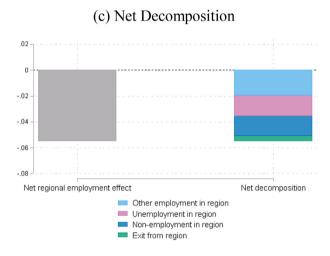
(a) Inflows and Outflows

Inflows regional employment
Outflows regional employment

(b) Establishment Entry and Exit

Establishment entry
Establishment exit
Intensive margin

(c) Net Decomposition

Other employment in region
Unemployment in region
Non-employment in region
Exit from region

Fig. 6. Decomposition of the overall reduction in local employment. Notes: Panel (a) decomposes the overall reduction in employment in the commuting zone from 2003 to 2006 in treated relative to control commuting zones, caused by the payroll tax increase, into changes in inflow into regional employment and outflow from regional employment. Panel (b) decomposes the employment reduction into establishment entry and exit, and employment changes in continuing firms. Panel (c) decomposes the employment reduction into the following components: (1) movements to and from private sector employment and into another type of employment in the region, (2) movements to and from regional unemployment (receipt of unemployment benefits), (3) movements to and from the labor force in the same region, (4) movements to and from the region. The decomposed employment reduction shares are obtained from estimating Eq. (8) using Et/E2003 as well as the various outcome variables described above, scaled by employment in the commuting zone in 2003, as the dependent variable. Reported estimates refer to the year 2006. Regressions are weighted by the number of workers in the commuting zone in 2003. There are 45 commuting zones (labor market regions), of which 11 are statutory treated and 34 are statutory control regions.
Data source: Norwegian register data made available by Statistics Norway.

7. Conclusion

In this paper, we investigate whether place-based payroll tax incentives are effective in boosting employment in low tax areas, focusing on the case of Norway. We exploit a unique policy setting in Norway, where a system of geographically differentiated payroll taxes was suddenly abolished. In particular, we take advantage of an EU regulation that required Norway to harmonize its payroll tax rates across regions between 2004 and 2006, which was then adopted and implemented independently of the local labor market developments, thereby creating exogenous variation in the payroll tax rates across regions over time.

We find that a one percentage point increase in the payroll rate tax leads to a decline in wages in the local labor market of 0.32%, though this effect is imprecisely estimated. Taking into account that only large firms—which employ about 70% of workers in the local labor market—are subject to the payroll tax increase in our setting, this wage response implies a pass-through rate of 0.46%. While comparable to that found by Holmlund (1983) and Johansen and Klette (1997) in Sweden and Norway, this pass-through rate of 0.46 is lower than what Gruber (1997) and Anderson and Meyer (1997) find in the context of Chile

and the US (i.e., there, firms are able to fully shift the burden of payroll tax increases onto workers' wages). The lower pass-through rates in the context of Norway and Sweden may be due to much higher degrees of unionization and collective wage bargaining than in the US and Chile, which may make it difficult for firms to fully cut wages in response to the local payroll tax increases.

We further find that a one percentage point increase in the payroll tax rate leads to a decline in local employment by 1.37%. This drop in local employment is largely accounted for by workers transitioning from employment to un- or non-employment, rather than by workers moving to another region. When viewed through the lens of a competitive model (and taking into account the fact that only large firms are subject to the payroll tax hike in our context), our wage and employment response imply a labor demand elasticity of −3.60. This estimate falls in the upper range of estimates reported in the literature (see Lichter et al., 2015). One possible explanation for the high labor demand elasticity is that capital does not adjust over our three-year study period. Alternatively, the high labor demand elasticity could be a consequence of liquidity constraints that worsen when firms are faced with an adverse tax hike.

Agglomeration and local multiplier effects provide a yet another explanation for the strong employment decline in response to payroll tax hikes (and hence the inferred labor demand elasticity).

Overall, our findings indicate that place-based payroll tax incentives can be effective at stimulating employment in remote regions in Norway. Our findings further suggest that the employment response to place-based payroll tax incentives depends on the institutional context and will generally be higher when firms are unable to fully shift the burden of payroll tax increases onto workers' wages because of downward wage rigidities.

Appendix A

Given the statutory payroll tax rate τ, wage w and rental rate of capital r, firms choose labor L and flexible capital K to maximize profits

$$\max_{L,K} AL^{\alpha}\overline{K}^{(1-\alpha)(1-\mu)}K^{(1-\alpha)\mu} - w(1+\tau)L - rK$$

The first order conditions with respect to labor and capital inputs are such that

$$\alpha A\overline{K}^{(1-\alpha)(1-\mu)}K^{(1-\alpha)\mu}L^{\alpha-1} = w(1+\tau), \tag{A.1}$$

$$(1-\alpha)\mu A\overline{K}^{(1-\alpha)(1-\mu)}K^{\{(1-\alpha)\mu-1\}}L^{\alpha} = r. \tag{A.2}$$

Dividing either side of Eq. (A.1) by that of Eq. (A.2) and rearranging, we obtain

$$K = \left\{\frac{w(1+\tau)}{r}\frac{(1-\alpha)\mu}{\alpha}\right\}L. \tag{A.3}$$

Plugging Eq. (A.3) into Eq. (A.1) and taking logarithm, we obtain

$$\log(L) = C - \frac{1-(1-\alpha)\mu}{(1-\alpha)(1-\mu)}\{\log(w(1+\tau))\}, \tag{A.4}$$

where

$$C = \frac{1}{(1-\alpha)(1-\mu)} \times \left[\{1-(1-\alpha)\mu\}\log(\alpha) + (1-\alpha)\mu\log(1-\alpha) + (1-\alpha)\mu\log(\mu) + \log(A) + (1-\alpha)(1-\mu)\log(\overline{K}) - (1-\alpha)\mu\log(r)\right].$$

Totally differentiate Eq. (A.4) this expression to get

$$d\log L = \varepsilon^D\{d\log(w) + d\log(1+\tau)\}, \tag{A.5}$$

where

$$\varepsilon^D = -\frac{1-(1-\alpha)\mu}{(1-\alpha)(1-\mu)}$$

is the labor demand elasticity.

The reform implies $d\log(1+\tau) > 0$ for large firms (subject to the payroll tax increase) and $d\log(1+\tau) = 0$ for small firms (exempt from the payroll tax increase due to the subsidy).

Denote the quantity of labor employed by large (A) and small (U) firms by L^A and L^U, respectively. From Eq. (A.5),

$$d\log L^A = \varepsilon^D\{d\log w + d\log(1+\tau)\} \tag{A.6}$$

and

$$d\log L^U = \varepsilon^D d\log w \tag{A.7}$$

Dividing by $d\log(1+\tau)$, we obtain expressions (3) and (4) in the main text.

Denote the quantity of labor supplied in the local economy by L^S. In a fully competitive equilibrium with downward flexible wages, the wage rate w adjusts to clear the labor market:

$$L^S = L^A + L^U. \tag{A.8}$$

Let $\phi(\leq 1)$ denote the share of workers employed in large firms (i.e., $\phi = L^A/(L^A + L^U)$). Totally differentiating Eq. (A.8) and using the definition of ϕ, we obtain

$$d\log L^S = \phi\, d\log L^A + (1-\phi)\, d\log L^U. \tag{A.9}$$

Let ε^S denote the labor supply elasticity such that

$$\varepsilon^S = \frac{d \ \log L^S}{d \ \log(w)}.$$

Then, using expressions (A.6) and (A.7) for $d \log L^A$ and $d \log L^U$, Eq. (A.9) can be stated as

$$\varepsilon^S d \log(w) = \phi \ \varepsilon^D \{d \ \log(w) + d \ \log(1 + \tau)\} + (1 - \phi)\varepsilon^D \ d \ \log(w).$$

Re-arranging this expression, we obtain expression (4) in the main text:

$$\frac{d \ \log(w)}{d \ \log(1 + \tau)} = \frac{\phi \varepsilon^D}{\varepsilon^S - \varepsilon^D},$$

which shows the pass-through rate of payroll tax hikes on to wages when ϕ share of workers in the local labor market are employed in large firms subject to the tax increase (whereas $1 - \phi$ share of workers are in exempt firms).

Table A.1
Statutory payroll tax rates, 2000–2006, zones 1 to 5.

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
2000	14.1	10.6	6.4	5.1	0
2001	14.1	10.6	6.4	5.1	0
2002	14.1	10.6	6.4	5.1	0
2003	14.1	10.6	6.4	5.1	0
2004	14.1	14.1	8.3	7.3	0
2005	14.1	14.1	10.2	9.5	0
2006	14.1	14.1	12.1	11.7	0

Notes: The table shows the statutory payroll tax rates by tax zone (zones 1 to 5) and over time.
Data sources: The Norwegian Tax Authorities.

Table A.2
Effects of statutory payroll tax rates on local employment and wages - IV estimates.

	(1)	(2)	(3)
	First-stage	IV	
	Actual tax rate	Employment	Daily wage rate
Actual tax rate		−1.400***	−0.326**
		(0.514)	(0.158)
Predicted tax rate	0.980***		
	(0.021)		
Obs. (no. of commuting zones X years)	315	315	315

Notes: The table reports the IV counterpart of our baseline estimates presented in panel A of Table 2. The main regressor is the actual regional statutory tax rate (based on contemporary worker composition), which we instrument by the predicted regional statutory tax rate (calculated based on 2003 worker composition). First stage estimates are reported in column 1. IV estimates are presented in columns 2 and 3. All results are obtained from regressions at the level of the commuting zone of the outcome variables on $\log(1 + \text{statutory tax rate})$. Regressions additionally include controls for year and commuting zone fixed effects, as well as commuting zone sector shares in 2003 interacted with year dummy variables (as in Eq. (9)). The regressions are weighted by the number of workers in the commuting zone in 2003. Standard errors are clustered at the level of the commuting zone. There are 45 commuting zones (labor market regions), of which 11 are statutory treated and 34 are statutory control regions.
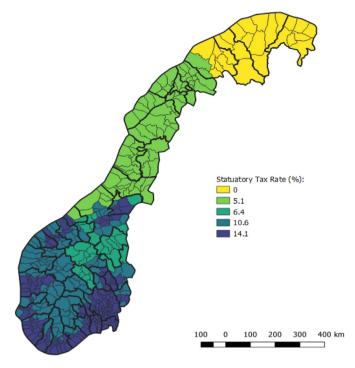* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

Fig. A.1. Tax zones and regional labor market regions, 2003. Notes: The figure shows the geographical distribution of tax zones and commuting zones (regional labor markets) in Norway in 2003 (pre-reform). In 2003 there were 434 municipalities (indicated by thin gray lines) and 46 commuting zones (indicated by thick black lines). Commuting zones are defined by Statistics Norway based on commuting flows (see Bhuller, 2009).

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