The Effects of Business Taxation on Local Labor Markets, Firms and Workers' Careers*

Thomas Cornelissen
Mimosa Distefano
Christian Dustmann
Uta Schönberg

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Abstract

This paper provides a comprehensive analysis of how local labor markets, firms, and workers adjust to changes in tax rates levied on firms' profits. We show that a rise in the local tax rate leads to a strong decline in the municipality's capital stock and a smaller decline in employment. Higher-paying establishments react the strongest and sharply reduce their hiring. This, in turn, decreases job churn and disrupts worker movements up the job ladder, leading to wage reductions over and above those observed within establishments. Our findings are compatible with a model of monopsonistic labor markets and heterogeneous firms. [99 words]

*Correspondence: Thomas Cornelissen, Department of Economics, University of Essex, Centre for Research and Analysis of Migration (CReAM), and Rockwool Foundation Berlin (RFBerlin). email: t.cornelissen@essex.ac.uk; Mimosa Distefano, Centre for Economic Performance (London School of Economics) and CReAM, email:m.distefano@lse.ac.uk; Christian Dustmann, Department of Economics, University College London, RFBerlin and CReAM, email: c.dustmann@ucl.ac.uk; Uta Schönberg, HKU Business School and Department of Economics, University College London, RFBerlin, CReAM, and Institute for Employment Research (IAB), email: u.schoenberg@ucl.ac.uk. We acknowledge funding by the ESRC (Grant Number ES/R005745/1). Schönberg acknowledges funding by ERC Consolidator Grant 818992. Dustmann acknowledges funding by ERC Advanced Grant 833861. Distefano acknowledges funding by the Fondazione Luigi Einaudi Onlus.

1 Introduction

The labor market effects of taxing firms' profits ("business taxes") are a matter of ongoing debate.[1] Some argue that increasing business taxes reduces workers' wages and destroys jobs, especially if tax increases are local, as firms will choose to locate in low-tax areas (e.g., Kotlikoff and Summers, 1987; Suárez Serrato and Zidar, 2016). Others maintain that, besides raising tax revenues, business tax increases may create jobs, as they raise the effective cost of capital if firms can only deduct part of their capital costs from profits (see, e.g., Stiglitz and Rosengard, 2015, section 23), which in turn may induce firms to replace capital with labor (Acemoglu, Manera, and Restrepo, 2020).[2]

This paper adds to this debate in several critical ways. First, we provide new and comprehensive evidence on how municipalities adjust their capital stock and employment following a local business tax change, drawing on full population data and a setting where business taxes vary over time across small spatial units. Second, we investigate the effect of business tax changes on employment flows, job mobility patterns, and their consequences for individual wage growth and workers' careers. We show that an increase in the local business tax rate lowers wages in the local labor market within affected establishments. Moreover, we also identify an indirect effect of a tax increase disrupting movements up the job ladder due to a reduction in hiring in higher-paying establishments. This indirect effect has so far gone unnoticed in the previous literature. Still, it explains more than half of the overall wage loss for workers in lower-paying firms and the entire wage loss for early-career workers. Finally, we illustrate that how local labor markets and firms respond to a business tax increase is not

[1] While the average rate of taxes on firm profits amongst major industrialized countries was close to 50 percent in the early 1980s (Devereux, Griffith, and Klemm, 2002), it fell to 30 percent around the turn of the century, and below 25 percent in 2015 (OECD Tax Database).

[2] Acemoglu, Manera, and Restrepo (2020) argue that the US tax code favors capital over labor, by taxing labor more than capital, and has led US firms to invest in automation at the expenses of labor.

compatible with a purely competitive labor market but can be explained by a model with a monopsonistic labor market. Overall, our analysis paints a comprehensive picture of the potential costs and benefits of local business taxation on municipalities, workers' careers, and firms, with important implications for the debate on the design of profit taxation.

Our study leverages variation in business tax rates in Germany over time and across local areas (municipalities) at a highly disaggregated geographical level.[3] For instance, in 2014, local tax rates ranged between 7 and 31.5 percent around a mean of 13.3 percent. An important advantage of our setting is that there are many persistent local business tax changes, allowing us to adopt an event study approach comparing treated municipalities (i.e., municipalities that experienced a persistent local business tax change of at least 0.35 percentage points) and control municipalities (i.e., municipalities that did not experience a local business tax change over our sample period). Our design allows for a four-year pre-period and studies effects up to 5 years after the tax change.

We draw on linked employer-employee data from German social security records comprising the near universe of establishments and workers from 1999 to 2014. This data allows us to investigate establishment entry and exit and within-establishment wage and employment changes and how these vary between establishments. We can also follow workers over time and across municipalities and establishments, enabling us to analyze the effects on individual job mobility and within- and between-establishment wage growth. To investigate how firms adjust their capital stocks in response to a business tax change, we complement the social security records with balance sheet data and income statements from Bureau van Dijk, the largest data source on firms available for Germany.

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[3] The same variation has been used by Becker, Egger, and Merlo (2012) and Fuest, Peichl and Siegloch (2018) to study firm entry and exit and within-firm wage responses to business tax changes, and by Lichter et al. (2022) who investigate the effect of local business taxes on establishments' R&D activities.

Our analysis reveals that a one percentage point increase in the business tax rate in the municipality lowers the capital stock three years later by 4 percent, employment by 1.17 percent, and wages by 0.52 percent. The decline in capital aligns with the business tax rate acting as an effective increase in the relative cost of capital, as firms can only partially deduct their capital costs from profits (see Auerbach, 2002, and section 2.2 for more details). The negative employment effect further suggests that the scale effect from the increase of the effective cost of capital dominates the substitution effect, and the wage effect of the same sign is in line with firms optimizing along an upward-sloping labor supply curve. Exploring the causes for the local employment reduction, we show that about half of the decline can be attributed to increased establishment exit, with the remainder due to a decrease in the capital stock and employment within surviving establishments.

We then investigate the implications of local business tax increases for individual wage growth, employment flows, and workers' careers. We document that the tax-induced local employment decline is driven by a sharp reduction in hiring and a smaller increase in separations into non-employment. Importantly, a business tax increase also reduces job-to-job churn (i.e., worker reallocation in excess of job reallocation), particularly workers' upward job moves to higher-paying establishments. As a result, a rise in the local business tax rate depresses not only workers' within-establishment wage growth (the effect studied by Fuest, Peichl, and Siegloch, 2018) but also upward job mobility, an important channel of wage growth for early career workers (e.g., Topel and Ward, 1992). We find that within-establishment wage growth is particularly affected for workers employed in a high-wage establishment before the tax change. In contrast, for those employed in lower-paying establishments before the tax increase, the wage losses due to forgone job move opportunities far exceed their wage losses at the current employer.

To better understand these worker-level findings, we investigate how the employment responses vary across firm types. We find that smaller and lower-paying establishments are more likely to exit in response to a business tax increase, while larger and higher-paying establishments experience larger wage declines and sharply reduce hiring. The strong reduction in hiring in higher-paying establishments explains why workers in lower-paying establishments find it more difficult to climb up the job ladder.

Our findings that employment and wages decline more in higher-paying than in lower-paying surviving establishments are hard to reconcile with a perfectly competitive labor market in which workers of the same type are paid the same wage across all firms. In the paper's final section, we argue that a model with heterogeneous firms and monopsonistic competition in the labor market can help interpret our results. In line with our empirical findings, the model unambiguously predicts an increase in exits of the least productive firms, which in equilibrium are also smaller and pay lower wages. The model also predicts larger capital stock and employment declines in more capital-intensive, larger, and higher-paying continuing firms, as observed in the data. Due to monopsonistic competition in the labor market, firms face an upward-sloping labor supply curve. This implies that firms that experience larger tax-induced employment declines will also experience larger wage declines, again in line with our empirical findings.

Our paper adds to the literature that has leveraged changes in business tax rates within a country across local labor markets to explore the effects of business taxation on employment (e.g., Suárez Serrato and Zidar, 2016 and Giroud and Rauh, 2019), wages (e.g., Arulampalam, Devereux, and Maffini, 2012 and Fuest, Peichl, and Siegloch, 2018), and the number of firms (e.g., Rathelot and Sillard, 2008; Becker, Egger, and Merlo, 2012).[4] Compared to Suárez

[4] An earlier literature on business taxation leverages cross-sectional corporate tax differences within countries or tax changes across countries to study the impact of corporate taxation on workers' wages (e.g., Felix, 2007;

Serrato and Zidar (2016) and Giroud and Rauh (2019), who investigate corporate tax cuts across states in the US, the changes in business tax rates in our setting refer to a much smaller geographical unit (municipalities vs. states). Consequently, we observe many more persistent tax changes, which allow us, in combination with rich administrative data, to assess the plausibility of the assumptions required for identification in an event study design and to obtain precise estimates for detailed heterogeneous responses to policy changes.[5] While Fuest, Peichl, and Siegloch (2018) consider the same setting as us, they focus on wages only.[6] We, in contrast, jointly investigate wage, employment, and capital responses.

We go beyond the existing literature by systematically analyzing labor market adjustments not only at the local and firm level but also at the worker level and by examining the mechanisms behind the employment and wage effects. Our analysis adds four crucial new insights to the literature. First, our findings highlight that the decline in the local capital stock is considerably larger than the decline in local employment. Second, we show that wage reductions experienced by workers hit by a business tax increase go beyond the within-establishment wage declines estimated by Fuest, Peichl, and Siegloch (2018), as a tax increase also reduces opportunities for upward job mobility in the local labor market, reducing between-establishment wage growth. This indirect channel has important career effects on two

Clausing, 2013; Azémar and Hubbard, 2015; Felix and Hines, 2022) or firms' location choices or investment decisions, often with a focus on multinationals (e.g., Coughlin, Terza, and Arromdee, 1991; Hines, 1996; Devereux and Griffith, 1998; Djankov et al., 2010). While these studies have provided important insights, they either rely on purely cross-sectional tax differences or exploit only a handful of cross-country tax changes, requiring strong assumptions for a causal interpretation.

[5] A related and complementary literature studies the employment effects of fiscal policies other than business taxation, such as bonus depreciation (Garrett, Ohrn, and Suárez Serrato, 2020; Tuzel and Zhang, 2021; Curtis et al., 2022), non-residential property taxes (Duranton, Gobillon, and Overman, 2011), local public spending (Gabe and Bell, 2004), or place-based policies that subsidize firms' investment costs of (typically manufacturing) firms (e.g., Criscuolo et al., 2019; Lerche, 2019; Siegloch, Wehrhöfer, and Etzel, 2021) or provide public investments to specific areas, as in the programmes studied by Busso, Gregory, and Kline (2013) and Kline and Moretti (2014).

[6] Fuest, Peichl, and Siegloch (2018) base their empirical analysis on the Linked Employee-Employer IAB data set (LIAB), an approximately 1% random sample of establishments linked to their employees' social security records and focus their analysis on within-firm wage changes. In contrast, we use the full population of German social security records and cover a longer period, from 1999 to 2014. This allows us to investigate not only within-firm wage responses but also local wage effects due to a decline in job-to-job mobility.

vulnerable groups: young workers and workers who work in low-productivity firms at the outset of the tax increase. Third, we uncover rich patterns of effect heterogeneity across firm types that help explain why business tax increases disrupt movements up the job ladder. Specifically, we show that high-paying firms located higher up the job ladder experience particularly sharp declines in employment and wages following an increase in the business tax rate. These firms adjust employment primarily by reducing hiring, causing a reduction in workers' upward mobility.

Fourth, we show that a local labor market model with heterogeneous firms and monopolistic product- and monopsonistic labor markets can rationalize our findings. As such, our paper relates to the growing literature on monopsonistic labor markets (e.g., Card 2022) by highlighting that models of monopsonistic competition are helpful not only to understanding wage differentials across firms (e.g., Card et al., 2018) or the employment effects of minimum wages (e.g., Bhaskar and To, 1999; Bhaskar, Manning and To, 2002; Dustmann et al., 2022) but also to rationalize heterogeneous responses across firms to local business tax increases.

2 Taxation of Business Profits

2.1 Institutional background

Business profits in Germany are taxed through federal corporate income tax, federal personal income tax, and local business tax. While only incorporated firms are subject to the corporate income tax (currently set at 15 %), the operating profits of proprietors of non-incorporated firms are taxed according to the progressive personal income tax. In contrast, the local business tax applies to incorporated and non-incorporated firms.[7]

[7] Only few firms are exempt from the local business tax, depending on their legal form and industry affiliation. These non-liable firms include most firms in agriculture and the public sector and certain professions such as accountants, lawyers, journalists, physicians, and artists. Our empirical analysis excludes these firms and focuses on liable firms.

In our setting, the local business tax rate τ_{mt} in a municipality m at time t consists of the basic tax rate set by the federal government, t_t^{fed}, and a collection rate set by the municipality, c_{mt}. The collection rate c_{mt} is set at the municipality's discretion by the municipality council, which votes on it yearly. Municipalities have no control over the basic tax rate f_t^{fed}. They also do not control which costs can be deducted from the tax base or which firms are exempt from the local business tax.

The *effective* business tax rate, the variation of which we exploit in our empirical analysis, equals:

$$\tau_{mt}^{eff} = \begin{cases} \dfrac{t_t^{fed} * c_{mt}}{1 + t_t^{fed} * c_{mt}} & \text{until 2007} \\ t_t^{fed} * c_{mt} & \text{from 2008} \end{cases} \tag{1}$$

This expression reflects that before 2008, firms were allowed to deduct the local business tax rate from the tax base. In terms of magnitude, the basic tax rate t_t^{fed} was reduced from 5 percent to 3.5 percent in 2008. In 2014, for instance, the collection rate c_{mt} varied between 2 and 9, such that the local business tax rate τ_{mt}^{eff} ranged between 7 percent and 31.5 percent across municipalities. Weighted by the number of employees in a municipality, the mean business tax rate in 2014 was 13.31 percent, with a standard deviation of 1.62 percent. In the same year, the 10th, 50th, and 90th percentiles of the weighted effective business tax rate distribution were 11, 13, and 17 percent, respectively.

The local business tax base is operating profits. While firms can deduct about 75% of their interest costs of debt financing from their tax base, equity financing costs such as dividends are not deductible.[8] The typical firm in Germany finances 36% of its investments through debt and 64% through equity and internal financing (European Investment Bank, 2019;

[8] See sections §§ 7-22 of the German corporate tax legislation (KStg), sections §§ 15-17 of the Income tax legislation (EStG) and sections §§ 8-9 of the business tax legislation (GewStG).

Statistische Bundesamt, 2011). Thus, firms can deduct about 27% (0.75×0.36) of their rental capital costs from the tax base. In addition, German firms can subtract depreciation allowances amounting to a net present value of about 60% of their capital investments.[9]

Municipalities collect the local business tax from firms that engage in commercial activity within the municipality boundaries. For firms with multiple establishments across several municipalities, the taxable profit is based on the firm's wage bill share.[10] This limits firms' opportunities to shift profits to municipalities with lower collection rates, as this would require moving workers between establishments in different municipalities.

Local business taxes form an important component of municipal revenues. In 2014, 37.2% of municipal revenues were from taxes, of which business tax revenues accounted for 79% (own calculation based on Destatis, 2022a). The remainder were from upper-level state or central government transfers over which municipalities have little control or other income sources, such as fees for local public services.[11]

Municipalities' main expenditures are social benefits to eligible residents, and they have little discretion over the benefit level or its eligibility criteria. Municipalities are also responsible for providing local public services such as rubbish disposal, water, and sewage, in addition to providing and maintaining school and nursery buildings, public parks, sports facilities, etc.

[9] We derive this number from Hogreve and Bunn (2022). These authors report an aggregate number of 66% for Germany. We reweight their underlying data across asset classes and time periods to resemble more closely the time and industry composition of our estimation sample, yielding an adjusted value of 60% (see Appendix D.8 for details).

[10] To illustrate, suppose that a firm has three establishments in three different municipalities (indexed by subscripts 1, 2, and 3) with different collection rates. Denote the firm's total wage bill by $W = w_1 + w_2 + w_3$ and its total profits by Π. According to the apportionment formula, tax revenues for each municipality are equal to $\tau^m \left(\frac{w_m}{W}\right) \Pi$.

[11] Local business taxes also form an important part of total tax revenues from profit taxation. In 2021 tax revenue from the local business tax was €61bn, compared to €42bn from corporation tax—see Table ZR.1 in Destatis (2022a). The same source reports €72bn of personal income tax receipts from income sources other than wages, of which an estimated 65% is from business activity (own calculations on the income sources for income tax based on Table A5 in Destatis, 2022b). This suggests a local business tax share in total profit taxation of 41% ($61/(61 + 42 + 0.65 * 72) = 0.41$).

2.2 The local business tax as a tax on capital

As explained above, firms in Germany can only partially deduct their capital costs from profits—which implies that an increase in the tax rate on a firm's profits increases the firm's effective cost of capital (e.g., Stiglitz and Rosengard, 2015). To see this, let a firm's pre-tax profit function given by

$$\pi_j^{\text{pre-tax}} = p_j y_j - w_j l_j - (r + \delta) k_j - C$$

where p_j denotes the product price that firm j charges; y_j, l_j, and k_j denote the firm's output, labor, and capital choices; w_j is the wage rate that the firm pays to all its workers; r is the interest rate; δ is the depreciation rate of capital assets and C denotes the fixed cost of production. Consider a local economy m that levies a business tax with an effective rate τ^m. In the hypothetical case that firms can fully deduct all costs from the tax base, after-tax profits would be given by

$$p_j(1-\tau^m)y_j - w_j(1-\tau^m)l_j - (r + \delta)(1-\tau^m)k_j - C(1-\tau^m),$$

and the tax would introduce no distortion in the effective factor prices. However, if we consider that firms can only deduct parts of their rental cost of capital and specific amounts of depreciation allowances, after-tax profits for firm j in municipality m are

$$\pi_j^m = p_j(1-\tau^m)y_j - w_j(1-\tau^m)l_j - (1-\tau^m D)[r(1-\alpha\tau^m) + \delta]k_j - C(1-\tau^m), \quad (2)$$

where α $(0 < \alpha < 1)$ is a parameter representing the share of the capital costs that can be deducted from the tax base, and D represents the net present value of capital allowances as a share of the capital invested. Deductibility of the full capital expense at the point of purchase (full expensing) would imply $D = 1$, whereas delayed capital allowances that aim to track depreciation over time imply $D < 1$. Dividing equation (2) by $(1-\tau^m)$ yields

$$\Pi_j = \frac{\pi_j^m}{(1-\tau^m)} = p_j y_j - w_j l_j - \underbrace{\frac{(1-\tau^m D)[r(1-\alpha\tau^m) + \delta]}{1-\tau^m}}_{R} k_j - C \qquad (3)$$

and reveals that the effective cost of capital is equal to $R = \frac{(1-\tau^m D)[r(1-\alpha\tau^m)+\delta]}{1-\tau^m}$. This is a version of the well-known user cost of capital (Hall and Jorgensen, 1967; King and Fullerton, 1983; Devereux and Griffith, 2003). As we show in Appendix D.6, a sufficient condition for R to be increasing in the local business tax rate is that $D + \alpha < 1$, which holds at the parameters relevant in our context (α=.27, *D*=.60—see section 2.1). Thus, through its effect on the effective cost of capital, a rise in the local business tax rate will increase the relative cost of capital and will affect the labor and capital choices of firms in the local municipality.

3 Data

3.1 Data Overview

Social Security Records and Business Tax Rates. Our primary data are Social Security Records from the *Beschäftigtenhistorik* (*BEH*), provided by the Institute for Employment Research in Nuremberg (IAB). This data source comprises all men and women covered by the German social security system (roughly 77.2% of workers), with self-employed workers, military personnel, and civil servants excluded. Our data set reports workers' primary employment relationships as of June 30 each year, from 1999 to 2014. Information on business tax rates, specifically the municipality's collection rate, is available from the 16 statistical offices of the German states from 1992 onward.

Our data set contains information on establishment locations at the level where the local business tax rate is set (the municipality). It allows us to precisely measure employment and wages at that level and follow workers across establishments and municipalities, making it possible to study how local employment and wages adjust. The large sample size and detailed information on workers and establishments—such as workers' education, establishment size and sector, and establishment entries and exits—enable us to paint a clear picture of how particular types of workers and establishments differentially respond to business tax changes.

As is typical in administrative data sets, the wage variable is top-coded at the social security limit. This affects 8% of workers in our sample. Following Dustmann, Ludsteck, and Schönberg (2009) and Card, Heining, and Kline (2013), we impute censored wages—see Appendix A.1 for details on the imputation. We further harmonize workers' education and full- vs. part-time status and impute missing values similar to Fitzenberger, Osikominu, and Völter (2006) and Fitzenberger and Seidlitz (2020); see Appendix A.2 for details.

Our employment analysis is based on full- and part-time workers and workers in so-called marginal employment relationships, that is, employment relationships with less than ten working hours per week. We compute full-time equivalent employment by assigning weights of 1, 0.5, and 0.25 to full-time, part-time, and marginal work, respectively. We base our wage analysis on full-time workers because we do not observe detailed information on hours worked. The dependent variable is the average log wage in the establishment- and municipality-level wage regressions.

Bureau van Dijk. We add balance sheets and income statements from Bureau van Dijk to our primary data source to analyze firms' capital stock adjustment in response to a local business tax change.[12] Unlike the BEH, the Bureau van Dijk data includes information on firms, not establishments. We assign a municipality—and hence a business tax rate—to each firm based on the address of the firm's headquarters. We measure the firm's capital stock as fixed assets, the sum of tangible fixed assets (machinery, buildings, etc.), intangible fixed assets (formation

[12] We downloaded unconsolidated balance sheets and income statements for all firms from Bureau van Dijk's Amadeus database from 2008 to 2014 (543,748 firms).

expenses, research expenses, goodwill, development expenses, and all other expenses with a long-term effect), and other fixed assets (long-term investments, shares, and participations, pension funds), and check the robustness of our findings against a definition using only tangible and intangible fixed assets.

3.2 Sample Selection and Treatment Definition

Our empirical analysis focuses on establishments liable to the business tax rate (see Appendix A.3 for a definition). It restricts the sample to employees who are not currently in an apprenticeship and are between 18 and 65 years old. The establishment's municipality refers to territorial boundaries as of 2015, when there were 11,085 municipalities. Subject to territorial changes at least once during our sample period were 1,878 municipalities, mostly located in East Germany. Since we cannot correctly infer the business tax rate for these municipalities, we exclude them from our sample. We ended up with a balanced sample of 9,207 municipalities.

We then select treatment and control municipalities (see Panel A of Table 1 for a summary) from this database. Control municipalities never experienced a tax change over the 1992 to 2014 period (1,118 control municipalities). In contrast, treated municipalities experienced no tax change for at least four years, after which their effective tax rate τ_{mt}^{eff} changes by at least 0.35 percentage points over the 1999 to 2014 period, where this change is not followed by a subsequent shift in the opposite direction in the following four years.[13] This results in 4,815 treated municipalities. We focus on the first tax change for municipalities that experienced more than one tax change in the same direction. In our baseline specification, treated municipalities are in our sample for up to eight years (four years before and after the first tax change). To ensure that outliers do not drive our findings, we trim the sample and

[13] This corresponds to a change in the collection rate c_{mt} in equation (1) by at least 0.1.

exclude municipalities with an average wage in the top 3% of the municipality-level wage distribution (303 municipalities). We impose additional sample restrictions on the Bureau van Dijk data, as described in Appendix A.4. Table 2 shows that treated and control municipalities are very similar regarding industry structure, education structure, average wages, and average establishment size in the year before the tax change.[14]

3.3 Descriptive Evidence on Changes in Business Tax Rates

Panel B of Table 1 shows that almost all business tax changes in our sample (computed as in equation (1)) are tax increases (96 percent), a consequence of two trends over our sample period. First, municipalities faced increased expenditures on compulsory items they must provide but have little control over (i.e., social benefit payments). Second, municipalities experienced a decline in their revenues because of two federal reforms: the abolition of the capital tax in 1998 and the decrease in the federal business tax rate from 5 to 3.5 percent in 2008 (Döring and Feld, 2005; Büttner, Scheffler and von Schwerin, 2014).[15] Municipalities were, at best, only partially compensated for these increased expenditures and reduced revenues through larger transfers from the state or federal government.

The mean (initial) tax change in our sample (weighted by municipality employment in the year before the tax change) amounts to 0.96 percentage points, with a standard deviation of 0.72 percentage points. While about half of the tax changes surpass one percentage point and

[14] Since the year before the tax change is not defined for control municipalities, we weight the sample of control municipalities to mirror the year distribution in the sample of treated municipalities in the year before the tax change. Let f_t^T be the (worker-weighted) share of observations in the treated sample that fall in year *t*, and f_t^C the respective share for the control sample. We then weight the descriptive statistics for control municipalities by f_t^T/f_t^C.

[15] Before 1998, firms liable to the local business tax were also liable to the local capital tax (*Gewerbekapitalsteuer*), which taxed firms' net assets. The local capital tax made up 8% of municipalities' budgets, with capital tax revenues in former West Germany estimated at DM 6.78bn in 1996 [see https://www.kommunen.nrw/informationen/mitteilungen/datenbank/detailansicht/dokument/jahressteuergesetz-1997-stellungnahme-der-bundesvereinigung-der-kommunalen-spitzenverbaende.html, accessed on 20th September 2022], compared to a total West German municipality tax income of DM 85.6bn [see Table 1.1 in https://www.statistischebibliothek.de/mir/receive/DEHeft_mods_00132386, accessed on 20th September 2022].

16% surpass two percentage points, only 1% of tax changes exceed four percentage points. Figure 1 further highlights that tax changes in our sample are, by construction, highly persistent, amounting to about one percentage point in the third year after the tax change.

4 Empirical Strategy

Our empirical specification contrasts outcomes of treated and control municipalities (such as (log) employment or (log) full-time daily wages) in the years before and after the tax change.

4.1 Event Study Design

We start by estimating the following regression for an outcome y_{mt} in municipality m in calendar year t:

$$y_{mt} = \sum_{\substack{g=-3 \\ g \neq 0}}^{5} \gamma_g \, Event_{m,t}^{g} + \varphi_t + mun_m + e_{mt}, \qquad (4)$$

where the subscript g denotes the period relative to the (first) tax change in treated municipalities (the tax change occurs between $g = 0$ and $g = 1$). The variable $Event_{m,t}^{g}$ represents indicator variables equal to 1 (-1) if the municipality increased (decreased) the tax g periods ago (or, for $g < 0$, will increase the tax in g periods) and 0 otherwise. Calendar year and municipality fixed effects are denoted by φ_t and mun_m, respectively.

The parameters of interest in equation (4) are the coefficients γ_1 to γ_5, which measure the change in the outcome of interest (e.g. (log) employment) in treated municipalities between g years after and the year before ($g = 0$) the tax change relative to control municipalities. Since the mean tax change in treated municipalities is close to 1 percentage point three years after the tax change (see Figure 1), these coefficients can be roughly interpreted as the local employment or wage effects of a one percentage point increase in the business tax rate.

The existing literature often reports estimated effects as elasticities with respect to one minus the business tax rate, i.e., they use $\log(1-\tau)$ as the primary variable of interest in a difference-in-difference specification; see, for example, Suárez Serrato and Zidar (2016) and Fuest, Peichl, and Siegloch (2018). For low baseline tax rates, a one *percentage point* increase in τ roughly corresponds to a one *percent* decrease in $(1-\tau)$. Our estimates (with flipped sign) can, therefore, also be interpreted as elasticities, referring to the effects of an increase in $(1-\tau)$ of approximately one percent.[16]

While we plot coefficients γ_{-3} to γ_5 in the event study figures, we focus on the effects three years after the tax change in the tables. When estimating equation (4), we weigh observations by employment in the municipality to make estimates representative of *workers* in our sample.[17] We cluster standard errors at the municipality level.

A causal interpretation of the estimated effects of γ_1 to γ_5 rests on the assumption that outcomes in treated municipalities would have evolved in the same way as outcomes in control municipalities if the change in business tax rates had not occurred. This assumption will be violated if tax rate changes are implemented for reasons that affect the economic outcomes of the municipality. One approach used in the literature to deal with this has been to implement a narrative approach based on collecting media coverage on the reasons for tax changes to identify those due to arguably exogenous reasons (Giroud and Rauh, 2019; Romer and Romer 2010). Given that our tax variation is at the most local level where media coverage for the reasons of tax changes is low and involves a huge number of tax changes (4,815 municipality-level tax changes), a narrative approach to identify the reasons for each tax change is not

[16] We report $\frac{\partial \ln y}{\partial \tau}$, interpretable as the relative effect (in percent) on y of a one percentage point change in τ. The literature often reports $\frac{\partial \ln y}{\partial \ln(1-\tau)}$, the elasticity of y with respect to $1-\tau$. Due to $\frac{\partial \ln y}{\partial \ln(1-\tau)} = \frac{\partial \ln y / \partial \tau}{\partial \ln(1-\tau)/\partial \tau} = -(1-\tau)\frac{\partial \ln y}{\partial \tau}$, both these effects are equivalent with flipped sign if $1-\tau$ is close to 1.

[17] We weight by current municipality employment in the log-wage regressions and by municipality employment in 1999 (i.e., before the first tax change in our sample) in the employment regressions.

feasible.[18] We, therefore, deal with potential endogeneity in alternative ways. First, we implement an event-study approach that allows us to check for pre-trends. If endogenous reasons and their effect on economic activity precede the tax change, they would be visible as diverging pre-trends between treatment and control municipalities. Thus, we check whether treated and control municipalities experience similar trends in outcomes before the business tax change by verifying that coefficients γ_{-3} to γ_{-1} are closely centered around zero. We show below that this is indeed the case. It is conceivable, however, that the reasons for the tax change affect economic outcomes only after the tax change, and this would then not be visible in pre-trends. To account for this eventuality, we run a range of robustness checks in which we augment the baseline specification by interacting year effects with dummies for broader geographic areas (commuting zones) and with detailed baseline municipality characteristics capturing the employment structure and its trends before the tax change (see section 5.2 for details).[19]

A further worry could be that reallocation of economic activity from municipalities that implement a tax change could lead to a spillover on municipalities of the control group, violating the Stable Unit Treatment Value Assumption. We address this worry in section 5.2 by directly estimating spillovers to other municipalities.

Finally, recent literature has pointed out that unrestricted treatment effect heterogeneity can bias traditional event-study designs with staggered treatment adoption when estimating

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[18] Giroud and Rauh (2019) implement the narrative approach for 161 state-level tax changes. Following Romer and Romer (2010), they identify tax cuts as arguably exogenous if they are implemented for dealing with an inherited budget deficit or achieving some long-run goal (while tax cuts implemented to offset a change in government spending or some other factor likely to affect future output are labelled as endogenous). Using the subset of arguably exogenous tax changes, Giroud and Rauh (2019) find similar results as when using all tax changes, or when using arguably endogenous tax changes.

[19] It might be tempting to use non-liable establishments in the same locality as a further control group in a triple difference design. First, data limitations make this difficult. Liability depends on the industry, legal form, and in some cases of the interaction of industry and legal form. We can only proxy liability in a crude way via industries as we do not observe firms' legal form. More importantly, non-liable firms in the same locality may be indirectly affected by local tax changes and are therefore unlikely to be a valid control group.

equations such as (4) by OLS (Sun and Abraham, 2021; Borusyak, Jaravel, and Spiess, 2021). When implementing the imputation approach allowing for unrestricted treatment effect heterogeneity proposed by Borusyak, Jaravel, and Spiess (2021), we find very similar effects (Appendix C, Figure C.1).

4.2 Difference Design

We also estimate difference regressions that are largely equivalent to the event study regressions in equation (4) but have the advantage that overall tax-induced employment effects can be more easily decomposed into various components, such as the share that is attributable to establishment entry and exit, or movements into and out of non-employment; see Sections 5.2 and 5.4 and Appendix B. The difference design compares *changes* in employment (and other outcome variables) in treated and control municipalities:

$$\frac{E_{m,t} - E_{m,t-g}}{E_{m,t-g}} = \beta_g Treat_m + \eta_t + u_{mt}^g. \quad (5)$$

Here, $\frac{E_{m,t}-E_{m,t-g}}{E_{m,t-g}}$ denotes the percent change in employment in municipality *m* between t and $t-g$ and $Treat_m$ is an indicator variable equal to one for treated municipalities that experience a tax increase, minus one for treated municipalities that experience a tax cut, and zero for control municipalities. Calendar year fixed effects are denoted by η_t and u_{mt}^g is an error term. Note that β_g, η_t and u_{mt}^g in the difference specification given by equation (5) are roughly equal to $\gamma_g, \Delta\varphi_t$ and Δe_{mt} in the event study specification given by equation (4).[20]

[20] Small differences between the two designs occur because in the event study design the municipality and year effects are pooled across all event horizons, while in the difference design all parameters are event-horizon specific. Moreover, to decompose employment into its components, the difference design uses the relative employment change as the dependent variable whereas the event-study design uses log employment, leading to the effects only being approximately equal (i.e., log points versus percentage points). Finally, in the event study design we weight observations by current employment in the municipality, whereas we weight by municipality employment before the tax change (in *t-g*) in the difference design.

While we estimate regression equation (5) separately for each year after the business tax change, our discussion focuses on effects three years after the tax change (i.e., $g = 3$). As before, estimates correspond to the impact of a change in the local business tax of around one percentage point. We weight observations by municipality employment in $t - g$ and cluster standard errors at the municipality level.

5 Results

5.1 Local Labor Market Effects

We begin by investigating the effects of a local business tax increase on the local economy's employment, wages, capital stock, and number of establishments. As shown in Section 2.2, a business tax rise effectively increases the cost of capital. This leads to a scale effect (firms downsizing or exiting the market due to increased production costs) and a substitution effect (firms having an incentive to substitute capital with labor). While for capital input, both these effects work in the same direction, for labor input (employment), the two effects operate in opposite directions. Consequently, an increase in the local business tax should unambiguously lead to a decline in the local capital stock (and firm survival), while the effect on local employment is a priori ambiguous.[21] If, moreover, the labor supply curve to firms in the local economy is upward sloping, we would expect wage and employment responses to a local business tax increase to be the same sign.

We report local capital, employment, and wage effects in Figure 2, which shows event study estimates based on equation (4). The figure illustrates that all three outcomes evolved similarly in treated and control municipalities in the four years before the tax change, ruling out that treated municipalities enact tax changes in response to systematically differing pre-

[21] It should be noted that if firms are allowed to deduct their entire capital costs from the tax base, there would be only a scale effect but no substitution effect. That is, a business tax rate increase affects firms' entry and exit decisions (as their profits decrease) but not their capital and labor choices conditional on their location decisions.

trends in wages, employment, or capital. After the tax change, all three outcomes start declining in treated relative to control municipalities.

Regarding the capital stock (Panel A of Figure 2), a one percentage point increase in the tax rate decreases capital by 1.36 percent after one year and 4.03 percent after three years (see also column 1 of Panel A, Table 3). Panel B of Figure 2 highlights that employment in treated municipalities likewise declines relative to control municipalities after the tax increase. A one percentage point increase in the tax rate decreases employment by about 0.53 percent after one year and 1.17 percent after three years (see Table 3, column 1), suggesting that the scale effect dominates the substitution effect. Moreover, as expected, the effect on employment is smaller than the effect on capital, as the scale and substitution effects work in opposite directions for employment but in the same direction for capital.

Finally, wages decline in treated municipalities relative to control municipalities after the tax increase (Panel C of Figure 2). A one percentage point increase in the tax rate decreases wages by 0.23 percent after one year and 0.52 percent after three years (see also column 1 of Panel C, Table 3).

In column (2) of Table 3, we report estimates from the difference design as described in equation (5), for $g = 3$, three years after the tax increase. We find very similar results to the baseline event study design. In column (3), we re-estimate the difference design at the establishment level, restricting the sample to surviving establishments. This specification captures capital and employment adjustments *within* continuing establishments only, but not adjustments due to establishment entry and exit. The estimated coefficients remain negative but are smaller in magnitude than the employment and capital declines at the municipality level. The within-establishment wage response to the business tax increase is also smaller than the within-municipality wage response, pointing toward a tax-induced decline in the local employment share of high-paying establishments. This finding is consistent with our later findings that business tax increases make it harder for workers to climb the job ladder and move to establishments that pay higher wages (see Section 5.3).

Compared to previous literature, our estimated within-establishment employment and capital effects are larger than those found by Giroud and Rauh (2019). Moreover, our estimated local employment effects—which capture establishment entry and exit and within-establishment employment adjustments—are smaller than those found by Suárez Serrato and Zidar (2016).[22] Our estimated within-establishment wage responses are similar in magnitude to those reported in Fuest, Peichl, and Siegloch (2018) for a smaller sample and shorter estimation period.[23]

Our finding that employment effects identified from continuing firms are smaller than the effects identified at the municipality level suggests that establishment entry and exit may play an important role in the adjustment process. This is confirmed in Figure 3, which illustrates that the number of establishments, while evolving similarly before the tax increase, gradually declined in treated municipalities afterward, with a one percentage point increase in the tax rate reducing the number of establishments by 0.59 percent after three years.

To address the question of how much of the overall local employment effect is attributable to establishment entry and exit, Figure 4 decomposes the total local employment effect obtained from the difference design (column (2) of Panel B, Table 3) into an effect that arises within continuing establishments and effects that occur due to increased establishment

[22] Suárez Serrato and Zidar (2016) find that a cut in the state business tax rate by approximately one percentage point increases population in the state by between 3.78 and 4.28 percent over a 10-year period, compared to our estimate of 1.17 percent for employment over a three-year period. Giroud and Rauh (2019) report employment declines of 0.4 percent in establishments hit by a business tax increase of one percentage point, relative to unaffected establishments *belonging to the same multi-state firm*. Our estimated within-establishment response is, at 0.8 percent, larger. For a sample of manufacturing firms only, Giroud and Rauh (2019) also report effects on capital, which are about one third smaller than their employment effects.

[23] In contrast to our and Fuest, Peichl and Siegloch's (2018) findings, Giroud and Rauh (2019) report that establishments do not lower wages in response to a state-wide business tax increase relative to unaffected establishments in the same firm. One explanation for the absence of a wage response in their setting is that firms follow a national wage policy such that establishment wages within the same firm vary little with local conditions, in line with the findings by Hazell et al. (2022).

exit, reduced establishment entry, or increased establishment relocation whereby the establishment continues to exist but relocates to another municipality (see Appendix B.1 for details on the decomposition).[24] The figure highlights that close to half (48%) of the overall decline in local employment following a business tax increase is due to increased establishment exit, with within-establishment adjustments accounting for most of the remaining half (41%). In contrast, reduced entry and relocation play only a minor role.

5.2 Robustness, Threats to Identification and Spillovers

The absence of pre-trends in Figures 1-3 suggests municipalities do not systematically enact tax changes in response to improving or deteriorating economic conditions preceding the tax change. Yet, as discussed in section 4.1, if municipalities systematically enact tax changes for reasons correlated with *prospective* economic conditions, this could cause endogeneity that is invisible in pre-trends. The direction in which such endogeneity would bias the effect is a priori ambiguous and depends on whether tax rises are systematically enacted in anticipation of good or bad economic conditions.

We deal with this concern by augmenting our baseline specification by a range of additional controls that proxy for the counterfactual economic conditions in the absence of the tax change. In the first column of Table 4, we first replicate the baseline specification of the previous table. In column (2), we add commuting zone-by-year fixed effects, allowing for fully flexible differential time trends at the larger local labor market level.[25] This specification leverages variation in business tax rates over time across neighboring municipalities within the

[24] Employment changes due to establishment relocation are computed as the increase in municipality employment due to continuing establishments moving into the municipality (i.e., establishments that keep their ID but change municipalities), net of the loss of municipality employment from continuing establishments moving out of the municipality.

[25] In our sample, there are 247 commuting zones, with 14 municipalities on average. Commuting zones are non-overlapping regional delineations defined such that a high share of workers residing within the zone work within the same zone, and a low share of workers commute to work outside of the zone.

same commuting zone. Estimates across all three outcomes remain similar to our baseline results. In column (3), we add several important baseline municipality characteristics interacted with year effects. For the wage and employment regressions (Panels B and C), these characteristics are measured in 1999 (the first year of our baseline observation period) and include industry structure (twelve 1-digit industry employment shares), municipality size (ten decile bins of employment), number of establishments (ten decile bins), the share of workers with a college degree (five quintile bins), and the 1994 to 1999 relative change in employment and the number of establishments (ten decile bins). For the sample used in the capital regressions (Panel A), the characteristics are measured in 2008 and include similar twelve industry shares and ten decile bins of baseline employment, the baseline number of firms, and baseline total capital. These specifications eliminate any differential trends in the outcomes between treated and control municipalities that the municipalities' baseline economic structure can explain. Again, the estimated effects are close to our baseline estimates. Our results also remain robust when jointly including commuting-zone-by-year and baseline municipality characteristics-by-year effects (column 4). Thus, our estimates consistently reveal negative effects on capital, employment and wages following a tax increase even after comprehensively accounting for possible differential trends that could be related to endogenous tax changes as described by Romer and Romer (2010). The robustness of results across specifications broadly aligns with Giroud and Rauh's (2019) finding of largely identical results when using arguably exogenous and endogenous tax changes.

Estimates in column (5) show that the effect of a change in the local business tax on capital remains robust when the definition of capital is changed. In this specification, we define capital only by tangible and intangible assets and exclude long-term investments in financial assets and pension funds.

Finally, if employment shifts from a municipality hit by a business tax hike to neighboring municipalities, the local employment response could be over-estimated when neighboring municipalities form part of the control group. If this problem is present, it should be more pronounced in the specification with commuting zone by year effects (column 2 of Table 4), which focuses the comparison on neighboring municipalities within the same commuting zone. However, in this specification, estimated effects are slightly smaller, implying that spillovers are not very strong. In column (6) of Table 4, we directly explore spillover effects on other municipalities in the same commuting zone. We find that neighboring municipalities' capital, employment, and wages remain largely unchanged following a tax change in the focal municipality. Thus, we do not expect our estimates to be strongly affected by employment shifts from directly affected to neighboring municipalities.

5.3 Business Tax Increases and the Careers of Workers

5.3.1 Worker flows

To understand what these shocks to the local labor market imply for workers, we investigate the effects of a local business tax increase on worker flows. We first decompose the total local employment change (column 2, Table 3) into reduced hiring and increased separations (see Appendix B.2 for details). The estimates in Table 5 (Panel A) indicate that nearly all of the tax-induced decline in local employment is due to reduced hiring. Separations from establishments, in contrast, remain essentially unchanged.

A more nuanced picture emerges when we distinguish between separations into employment and non-employment in Panel B. Estimates in column 2 reveal that an increase in the business tax by one percentage point leads to a 0.52 percentage point higher probability that a worker employed before the tax increase (“incumbent”) is not employed after three years. Yet, total separation rates (column 1) do not change in response to a tax increase because incumbent workers are less likely to move to another establishment (column 3). At the same time, hiring rates from employment strongly decline following the rise in the local business tax (column 3 of Panel C), explaining large parts of the total reduction in hiring.

While some of these worker flows are a direct consequence of job creation and destruction, we next investigate whether tax changes affect churning, defined as worker flows in excess of job creation and destruction.[26] Such worker reallocation in continuing job positions more directly reflects employers' and employees' re-evaluation of the value of their match, leading to workers moving to their most productive use (Lazear and Spletzer, 2012; Burgess, Lane and Stevens, 2000). The results in Panel D of Table 5 show that a one percentage point increase in the business tax rate reduces churn by 0.73 percentage points of baseline employment. This effect is driven mainly by churning involving "job-to-job" transitions rather than transitions to or from non-employment.

5.3.2 Mobility and Individual Wage Growth

Thus, higher local business taxes decrease churn in the local economy, similar to recessions (Lazear and Spletzer, 2012), reducing workers' options to move to more productive job matches. As job mobility is a crucial determinant of individual wage growth (see, e.g., Stigler, 1962, Burdett, 1978, and Jovanovic, 1979 for theoretical considerations and Topel and Ward, 1992 and Adda and Dustmann, 2023 for empirical evidence for the US and Germany, respectively), we next explore the effects of local business tax increases on workers' wage growth through reduced job mobility. We focus on workers who were employed full-time before the tax change and who continue full-time employment (in any establishment) three years later.

[26] We compute churn as the sum of separations in expanding establishments, hirings in contracting establishments, and separations (or hirings) in establishments in which employment remains constant (see Lazear and Spletzer, 2012), divided over baseline employment.

Panel A of Table 6 shows that workers hit by a business tax increase are less likely to move to a new establishment and have worked for fewer establishments than workers in control municipalities. In magnitude, a one percentage point increase in the business tax reduces the probability of an employer switch by 0.98 percentage points. Moreover, the likelihood of upward movements, defined as a move to establishments that pay higher wage premiums or movements that result in wage increases, is particularly affected (last two columns).

In Panel B of Table 6, we report estimates for the effects of local business taxation on individual wage growth, focusing on the total wage change and the wage change conditional on staying with the previous employer or moving to a different establishment. Business tax increases appear to cause more considerable wage reductions for workers who switch to a new employer over the three years than for workers who remain employed with their previous employer, suggesting that a local business tax increase reduces the probability and gains of moving jobs.

We would expect the wage loss from reduced gains of job moves to be greater for workers in low-wage firms and early in their careers, as these workers have the most to gain from moving up the job ladder. Panel C breaks down the wage analysis according to whether the worker was employed in a low-, medium- or high-paying establishment before the tax change. The numbers in the second column reveal that within-establishment wage declines (i.e., conditional on staying with the establishment) are smaller for workers employed in low-paying establishments before the tax increase. As we argue in the next section, this is because lower-paying firms are also less capital intensive and hence less affected by an increase in the cost of capital. Yet, workers in these establishments suffer at least as high overall wage declines as workers previously employed in higher-paying establishments due to larger reductions in job mobility and larger wage declines when switching establishments. Thus, these estimates suggest that while workers from low-paying establishments have the most to gain from job mobility, the business tax increase makes it harder for them to move to more productive job matches.

In the final columns of Panels B and C, we report results from two simple statistical decompositions to derive the share of the wage decline that is due to the reduction in upward job mobility (i.e., the indirect wage impact of business tax changes through reduced churning). The decomposition in column (i) evaluates the tax-induced reduction in the returns to moving relative to the wage change of stayers. The decomposition in column (ii) is more descriptive and does not use the wage change of stayers as the counterfactual for movers; see Appendix B.3 for details. The decompositions attribute about 70%-80% of the tax-induced overall wage decline experienced by workers employed in a low-paying establishment before the tax increase to reduced upward job mobility rather than the direct within-firm effect that is the focus of the existing literature. As the last row in Panel C shows, this number rises to 92%-96% for workers below 30, in line with the findings by Topel and Ward (1992) that job mobility is a crucial driver of wage growth, particularly for young workers.

5.4 Why Local Business Tax disrupt the job ladder—Heterogeneity Across Establishments

To understand the mechanisms that drive the reduction in job mobility and the gains from mobility, we investigate the heterogeneous effects of the business tax across establishments. As the business tax raises the effective cost of capital, we would expect more capital-intensive firms to be hit harder by an increase in the local business tax rate and, hence, to adjust their capital stock and employment by more than less capital-intensive firms. Since more capital-intensive firms also pay higher wages and hence are located higher up in the job ladder (e.g., Abowd, Kramarz, and Margolis, 1999; Oi and Idson, 1999; Arai, 2003), stronger employment and capital reductions in these firms would help explain why workers' job ladders are disrupted.

To explore firm heterogeneity in response to business tax increases, we report results from establishment-level regressions using the difference design (equation 5), estimated separately by establishment type (Table 7). We distinguish establishments by their AKM establishment fixed effect estimated from a wage regression over seven years before the tax change, with one-third of workers employed in each category (high, medium, and low-paying establishments).[27] The estimates show that the employment response is about twice as large in establishments with a high (rather than low) AKM establishment fixed effect (Panel A). At the same time, wage declines are nearly four times larger in high-paying than low-paying establishments (Panel B), in line with our previous finding that incumbent workers in lower-paying establishments suffer larger wage declines if they remain employed with their employer. In Panel C, we further show that firms with an above-median capital-employment ratio reduce their capital stock almost three times more than firms with a below-median ratio. Overall, these findings suggest that employment and capital decline more in firms higher up the job ladder following an increase in the business tax rate.

In Panel D of Table 6, we further show that a sharp decrease in hiring drives the strong employment reduction in high-wage firms. Moreover, firm-level churn in high-wage firms reduces, implying that worker reallocation in excess of job reallocation is reduced. These findings suggest fewer job openings in the local economy, particularly in establishments higher up the job ladder.

[27] To compute AKM-style worker and establishment fixed effects, we use the universe of full-time workers not in apprenticeship training aged between 18 and 65, including those in establishments that are not liable to the business tax. Specifically, we use social security records from the BEH referring to June 30 for the years 1992 to 2014 to estimate AKM-style wage regressions for all possible 7-year windows within this period (i.e., 1992-1998, 1993-1999, … 2008-2014).

While wage and employment declines in surviving establishments are more pronounced within higher-paying establishments, establishment exit is primarily driven by lower-paying establishments. We illustrate this in Figure 5, where we decompose the local employment decline attributable to establishment exit into three components stemming from low-, medium-, and high-paying establishments (based on their AKM establishment fixed effect); see Appendix B.1 for details on the decomposition. The figure highlights that the tax-induced decline in local employment due to establishment exit is largely due to the withdrawal of low-paying and (to a lesser extent) medium-paying establishments. In contrast, high-paying establishments are not more likely to exit following a tax increase. Note that the tax-induced exit of lower-paying establishments will increase the number of job seekers in the local economy. This increased competition for jobs provides a further reason why moving up the job ladder becomes more difficult, in addition to the lower availability of job openings in higher-paying establishments.

Thus, reductions in job-to-job mobility and gains from moving are key channels contributing to the local wage decline following a business tax increase, and firm heterogeneity in the response to the business tax increase is a crucial element explaining the disruption in the job ladder.

6 Competitive Market or Monopsony?

Our empirical findings of heterogeneous employment and capital responses across establishments in conjunction with heterogeneous wage responses that point in the same direction are incompatible with a perfectly competitive labor market where workers of the same type are paid the same wage, regardless of the firm they work for.[28] Appendix D shows that

[28] Differential wage and employment responses across firms to a business tax change are in principle compatible with a perfectly competitive local labor market model if firms differ in their skill mix, and local business tax

our findings align with a model with firm heterogeneity, monopolistic competition in the product market, and monopsonistic competition in the labor market. In this section, we discuss the ingredients of the model and provide an intuitive discussion of its implications and how it aligns with our empirical findings.

Firms produce with capital and labor inputs. A business tax increase, which amounts to a rise in the effective cost of capital (see section 2.2), generates on the side of firms a substitution effect governed by the degree of substitutability between labor and capital and a scale effect governed by consumers' demand response to a change in firms' output prices. For capital, the substitution and scale effects are both negative, whereas for labor, the substitution effect is positive, while the scale effect is negative. The model implies that if the magnitude of the price elasticity of output demand η exceeds that of the elasticity of substitution between capital and labor σ, the scale effect dominates the substitution effect. Thus, firms will reduce both capital and labor.

Moreover, as monopsonistic firms adjust by moving down the upward-sloping labor supply curve, they reduce wages as they reduce employment.[29] These overall capital, employment, and wage effects precisely align with our findings in Figure 2 and Table 3. The model additionally implies that the elasticity of substitution between labor and capital can be identified by combining our empirical results with an expression of the effective cost of capital that we can derive under plausible assumptions. Our estimated capital, employment, and wage effects of a business tax change imply an elasticity of substitution $\sigma = 0.85$ (see Appendix D.8 for details).

changes differentially affect employment and wages by worker skill. This is contradicted by our findings in Panels B and C of Table 6 which illustrate within-worker wage declines (i.e., holding skill constant) that are more pronounced in high- than in low-wage firms holding workforce composition constant (i.e., conditional on staying with the same firm).

[29] Firms that are price-takers in the labor market, on the other hand, would adjust only employment.

The model further predicts that more highly productive firms are larger, pay higher wages, and are more capital intensive (in line with empirical evidence that larger firms are more capital intensive, e.g., Abowd, Kramarz, and Margolis, 1999; Oi and Idson, 1999; Arai, 2003). Crucially, more capital-intensive firms react more strongly to a business tax rise because the cost of capital makes up a larger share of their overall cost of production. Therefore, the model explains why capital, employment, and wage declines following a local business tax increase are more pronounced in larger, higher-paying firms (Table 7). Less productive firms, on the other hand, are smaller, less capital-intensive, and less profitable. The model also predicts that, because of their smaller profit margins, small firms are more likely to be driven out of business following an increase in the business tax, thus accounting for our finding that the decline in the number of firms operating in the economy is predominantly driven by smaller, low-paying firms (Figures 3 and 5).

7 Discussion and Conclusion

Using variations in business tax changes across municipalities in Germany, we show that an increase in the business tax rate lowers the municipality's capital stock, employment, and wages. Our analysis provides the important and novel insight that business tax increases reduce job churning and slow upward mobility in the labor market, thereby disrupting workers' job ladder. The reduced job mobility and lower gains from moving are induced by the particularly sharp capital and employment reductions in more capital-intensive and higher-paying establishments that workers aspire to move to over the course of their careers. It predominantly affects workers at the lower rungs of the job ladder before the tax change, particularly young workers and workers in lower-paying establishments. Our analysis emphasizes the importance of the indirect effects of business tax changes over and above the direct effects within firms, which have been the focus of much of the existing literature.

Our findings are hard to reconcile with perfectly competitive local labor markets but align with the predictions of a local labor market model with heterogeneous firms, monopolistic product markets, and monopsonistic labor markets. Moreover, the large spread in business tax rates across municipalities (ranging from 7% to 31.5% in 2014) is inconsistent with perfectly frictionless product and labor markets. If labor markets were perfectly competitive and frictionless, wages would equalize across local markets. Similarly, if goods were perfect substitutes, firms could not raise product prices in response to a local business tax increase. In such a frictionless world, business tax rates must equalize across local markets; otherwise, all economic activity would disappear from areas with higher tax rates (see Appendix D.7).

Three final remarks are in order. First, the employment decline in response to a local business tax increase raises the possibility that the tax revenue collected by municipalities will diminish. This, however, is unlikely as the magnitude of our estimated employment response is sufficiently small to ensure that the reduction in the tax base is more than compensated for by the increased revenue raised from continuing firms, albeit in such a way that revenue increases less than proportional to the change in the tax rate.[30] Second, increased tax revenues may lead to increased public investments in the municipality, such as investments in rubbish disposal, local parks, nurseries, or sports facilities. If such investments increase local employment, our employment effects underestimate the employment loss without increased public investments. At the same time, increased public investments may improve residents' welfare, partly compensating them for wage declines and reduction in employment opportunities. Third, we focus on local tax changes, where we expect employment effects to

[30] To see this, let E_m and $\bar{\pi}_m$ denote the number of employees and average firm profits per employee in the municipality. The municipality therefore collects tax revenues equal to $TR_m = E_m \cdot \bar{\pi}_m \cdot \tau_m$. Assuming that average pre-tax-change firm profits per employee are unaffected by a local business tax increase and taking into account that local employment declines by 1.17 percent in response to a one percentage point increase in the business tax (Table 3, column (1)), an increase in the local business tax rate by one percentage point will increase local tax revenues according to $\frac{dTR_m}{d\tau_m} \approx E_m \cdot \bar{\pi}_m + \frac{d \log E_m}{d\tau_m} \cdot E_m \cdot \bar{\pi}_m \cdot \tau_m = E_m \cdot \bar{\pi}_m \cdot (1 - 1.17\tau_m)$. This expression is negative only for implausibly high business tax rates exceeding 85%.

be larger than for a national tax change, as workers are likely to be more mobile across local areas than across countries, and since aggregate product prices are likely to increase following a national tax increase.[31] Importantly, though, the heterogeneous wage and employment responses across firms uncovered in the empirical analysis that align with a monopsonistic labor market, as well as the decline in wage growth induced by the reduction in worker mobility, are at work regardless of whether the business tax change is local or national.

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[31] These two channels work in opposite directions for wages, with workers' lower mobility increasing the wage response and higher product prices dampening it, so that it is unclear whether wage effects would be smaller or larger for a national or local tax change.

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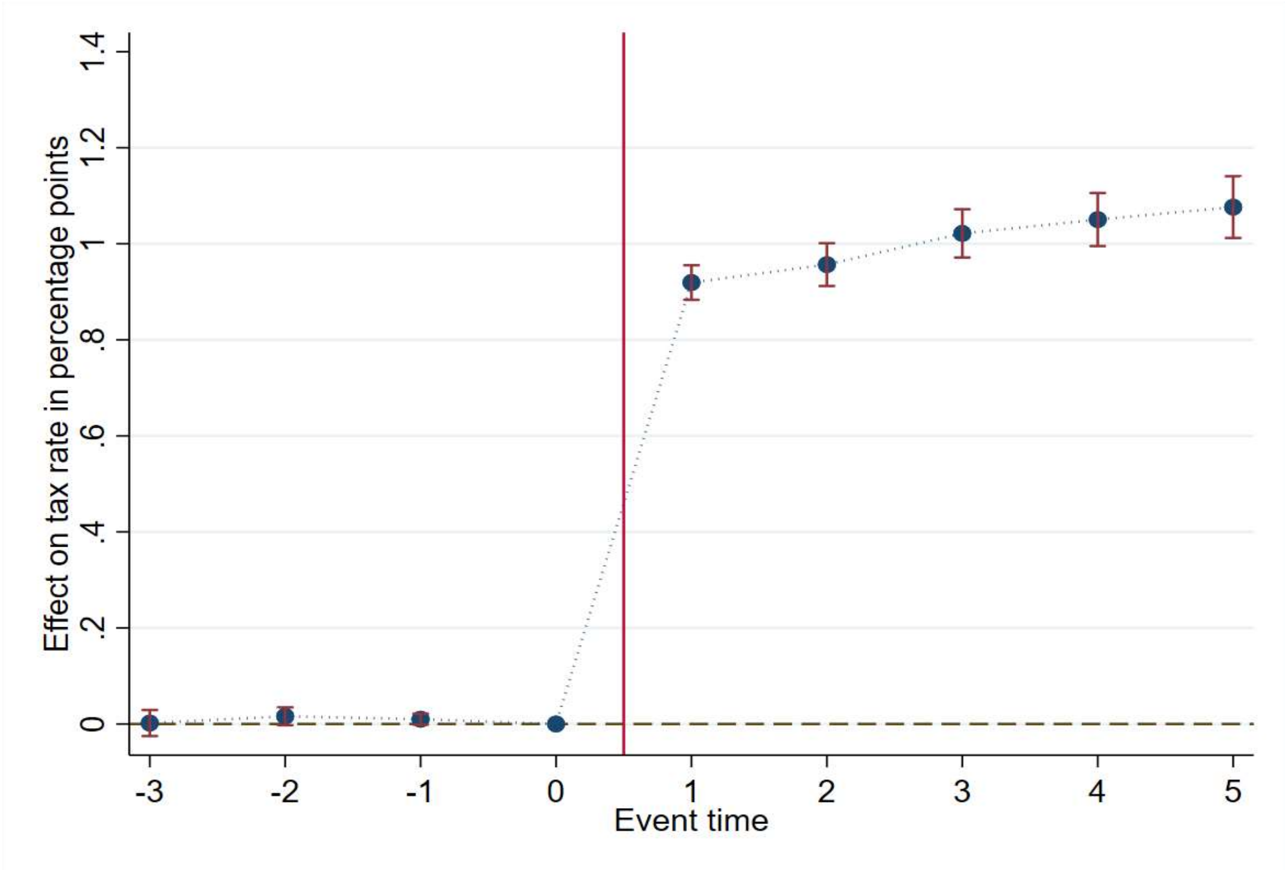
Figures and Tables

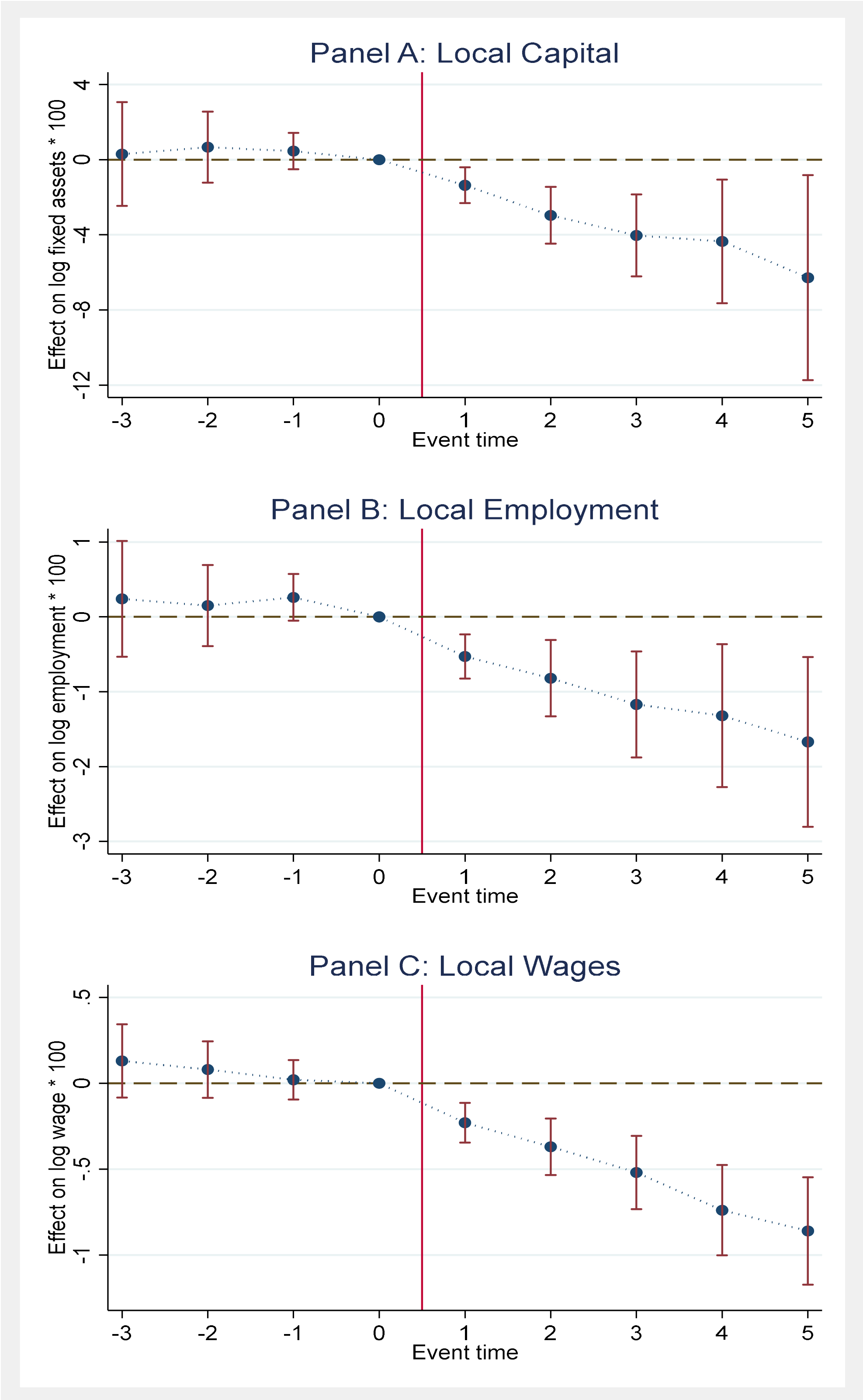
Figure 1: Business Tax Change Over Time: Treated vs Control Municipalities



Notes : The figure plots event study coefficients for the magnitude of the business tax change in treated municipalities relative to control municipalities, using the year before the tax change (event time 0) as the reference year. Coefficients are estimated from equation (4). 95%-confidence intervals are based on standard errors clustered at the municipality level.

Source : German Social Security Records from the *Beschäftigtenhistorik* (BEH).

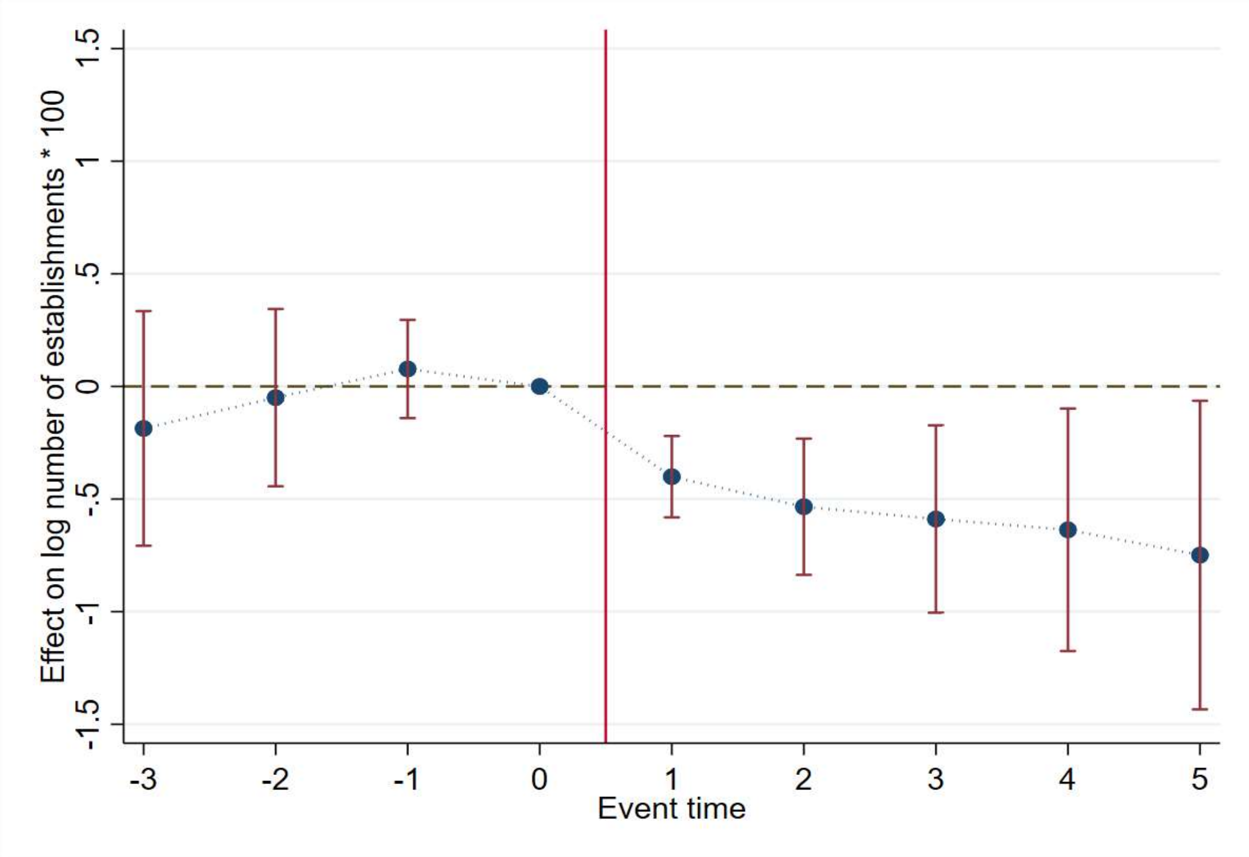
Figure 2: Effects of Business Taxation on Local Capital, Employment, and Wages



Notes: The figure shows event study coefficients for the effects of a business tax increase on local employment, wages and capital in treated municipalities relative to control municipalities, using the year before the tax change (event time 0) as the reference year. Coefficients are estimated from equation (4). 95%-confidence intervals are based on standard errors clustered at the municipality level.

Source : German Social Security Records from the *Beschäftigtenhistorik* (BEH) and Bureau van Dijk.

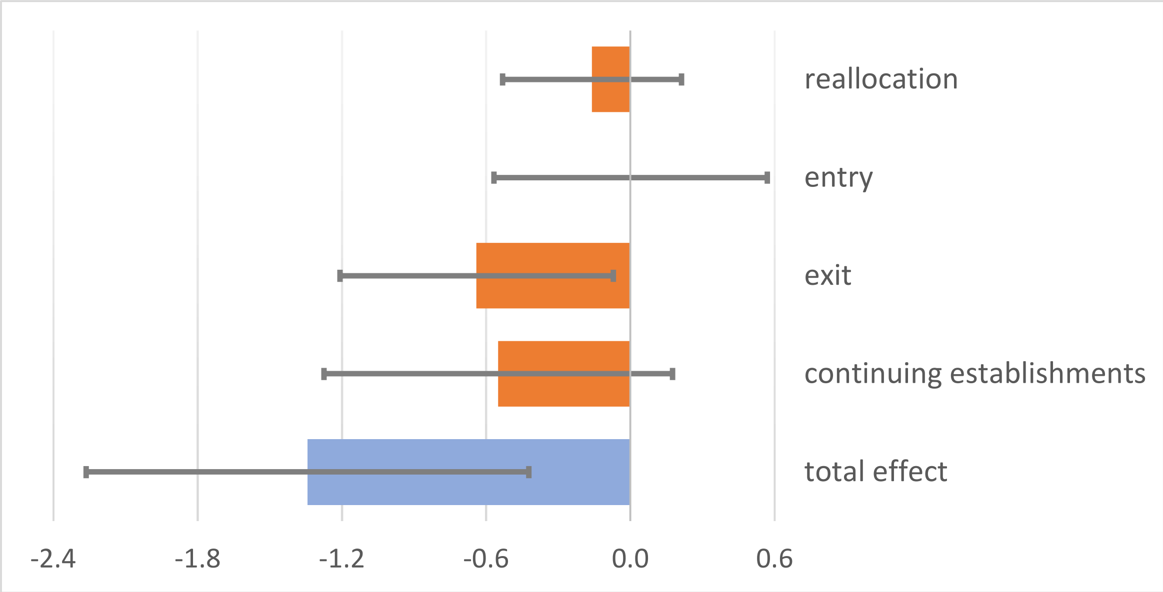
Figure 3: Effects of Business Taxation on Number of Establishments



Notes: The figure shows event study coefficients for the effects of a business tax increase on the log number of establishments (with minimum size of at least one FTE) in treated municipalities relative to control municipalities, using the year before the tax change (event time 0) as the reference year. Coefficients are estimated from equation (4). 95%-confidence intervals are based on standard errors clustered at the municipality level.

Source : German Social Security Records from the *Beschäftigtenhistorik* (BEH).

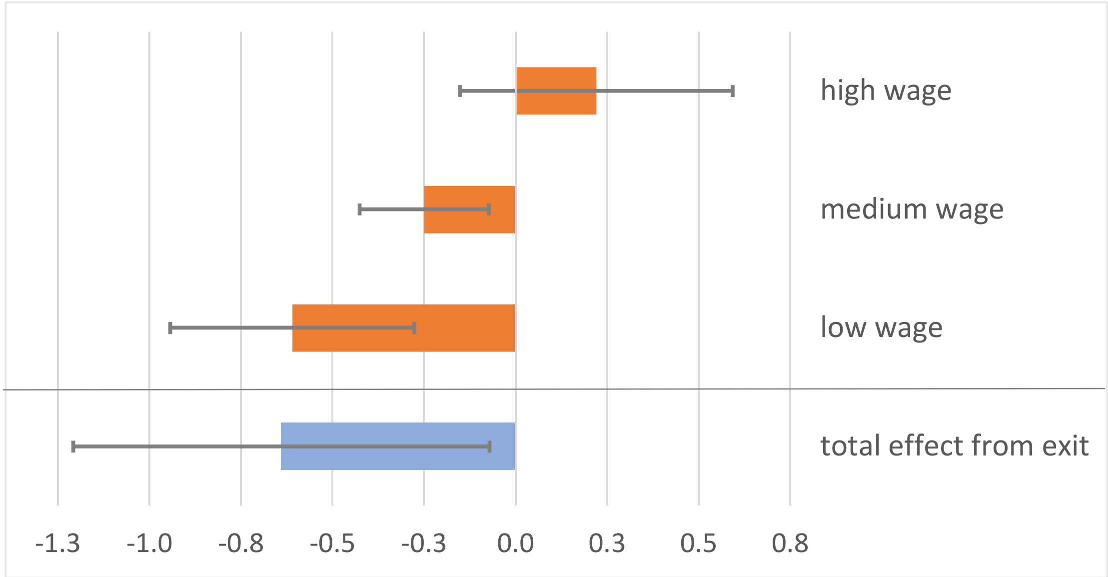
Figure 4: Decomposition of Local Employment Effect (3 Years after Tax increase)



Notes : The Figure decomposes the total local employment effect of column 2, Panel B, in Table 3 into effects due to employment changes among continuing establishments, establishment exit, establishment entry, and establishment reallocation across municipalities. See Section 5.1 and Appendix B.1 for details on the decompositions. 95%-confidence intervals are based on standard errors clustered at the municipality level.

Source : German Social Security Records from the *Beschäftigtenhistorik* (BEH).

Figure 5: Decomposition of Local Employment Effect from Exits by Firm Type (3 Years after Tax increase)



Notes : The Figure decomposes the effect due to establishment exits from Figure 4 by the establishment wage fixed effect. Wage fixed effects are estimated on a 7-year period prior to the tax change. Wage fixed effect groups are defined to represent equally sized shares of employment. See Section 5.4 and Appendix B.1 for details on the decompositions. 95%-confidence intervals are based on standard errors clustered at the municipality level.

Source : German Social Security Records from the *Beschäftigtenhistorik* (BEH).

Table 1: Sample structure, and Direction and Magnitude of Business Tax Changes

Panel A: Number of Treated, Control, and Dropped Municipalities	
Treated municipalities	4,815
Control municipalities	1,118
Dropped municipalities	
boundary change	1,878
small tax change or tax changes in opposite directions	2,025
trimming	303
Panel B: Direction of Business Tax Changes	
Tax increases	96%
Tax decreases	4%
Panel C: Magnitude of Business Tax Changes	
Mean	0.96 percentage points (6.7 percent)
Standard Deviation	0.72 percentage points (5.3 percent)
Share of tax changes > ¦1pp¦	0.54
Share of tax changes > ¦2pp¦	0.16
Share of tax changes > ¦4pp¦	0.01

Panel A of the table reports the number of treated and control municipalities in the estimation sample and the number of municipalities dropped from the sample. For treated municipalities, panel B shows the distribution of tax increases and decreases, and panel C provides information on the distribution (weighted by municipality employment in the year before the tax change) of the magnitude of tax changes.

Source : German Social Security Records from the *Beschäftigtenhistorik* (BEH).

Table 2. Treated vs Control Municipalities: Baseline Characteristics

	Treated municipalities	Control municipalities
Panel A: Industry structure (in percent)		
First sector (fishing, mining) and energy	2.1	1.8
Manufacturing	28.2	29.4
Construction and transport	12.9	13.4
Retail and hospitality	18.9	19.1
Real estate and other business activities	19.1	19.9
other	18.9	16.4
Panel B: Skill structure (in percent)		
low educated	10.1	9.4
middle educated	80.2	80.4
high educated	9.7	10.2
Panel C: Wages, Fulltime Status, Establishment size		
(log) Daily full-time wage	4.36	4.38
Low AKM firm effect	0.36	0.33
Medium AKM firm effect	0.37	0.37
High AKM firm effect	0.27	0.30
Share of fulltime workers	0.84	0.85
Establishment size	300	308

Notes: The table reports characteristics of treated (N=4,815) and control (N=1,118) municipalities in the year before the tax change, weighted by municipality employment.

Source : German Social Security Records from the *Beschäftigtenhistorik* (BEH).

Table 3. Effects of Business Taxation on Local Employment, Wages, and Capital (3 years after the tax change)

	(1) Baseline	(2) Difference specification (municipality)	(3) Difference specification (establishment)
Panel A: Effect on log capital * 100			
Effects three years after tax change	-4.03***	-3.55***	-2.41**
	(1.33)	(1.23)	(1.17)
Panel B: Effect on employment (in percent)			
Effects three years after tax change	-1.17***	-1.34***	-0.82**
	(0.43)	(0.47)	(0.40)
Panel C: Effect on log wage * 100			
Effects three years after tax change	-0.52***	-0.43***	-0.33***
	(0.13)	(0.12)	(0.12)
Municipality FE	Yes	Yes	-
Establishment FE	-	-	Yes
Year FE	Yes	Yes	Yes
Commuting zone by year FE	No	No	No
Industry shares (1-digit) by year FE	No	No	No

Notes : The table reports the effects of tax changes on municipalities' total capital, total employment, and average wages. Effects are measured three years after the tax change, scaled in percent, and can be interpreted as effects of a one-percentage-point increase in the local business tax rate. Column (1) reports the effect from the event-study regression of equation (4) and column (2) results from the municipality-level difference specification of equation (5). Column (3) reports results from a difference specification estimated at the level of (surviving) establishments with at least two employees. Standard errors clustered at the municipality level are in parentheses. * statistically significant at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level.

Source : German Social Security Records from the *Beschäftigtenhistorik* in Panels A and B. Bureau van Dijk

Table 4. Robustness Checks

	(1) Baseline	(2) Commuting zone by year FE	(3) Municipality controls by year FE	(4) Municipality controls by year and commuting zone by year FE	(5) Capital Definition	(6) Spillover to neighbouring municipalities
Panel A: Effect on log capital * 100						
Effects three years after tax change	-4.03***	-3.64**	-2.92**	-3.47**	-4.06***	0.073
	(1.33)	(1.69)	(1.21)	(1.67)	(1.41)	(0.098)
Panel B: Effect on employment (in percent)						
Effects three years after tax change	-1.17***	-0.96**	-1.12***	-0.74*	n.a	-0.26
	(0.43)	(0.40)	(0.30)	(0.40)		(0.40)
Panel C: Effect on log wage * 100						
Effects three years after tax change	-0.52***	-0.36**	-0.49***	-0.38***	n.a	-0.36
	(0.13)	(0.14)	(0.12)	(0.13)		(0.34)
Municipality and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Commuting zone by year FE		Yes		Yes		
Municipality controls by year FE			Yes	Yes		

Notes : Column (1) replicates the baseline specification of Table 3, and columns (2)-(4) augment the baseline specification by including commuting-zone-by-year effects and baseline municipality controls by year fixed effects.

The municipality controls interacted with year effects in Panels B and C are: employment shares of twelve 1-digit-industries, ten decile bins of employment in 1999, ten decile bins of the number of establishments in 1999, five quintile bins of the share of workers with college degree in 1999, 10 decile bins of the relative change in employment and for the relative change in the number of establishments between 1994 and 1999. The municipality controls interacted with year effects in Panel A are: similar twelve industry shares and ten bins of baseline employment and the baseline number of firms, with the baseline yeat being 2008, in addition to ten decile bins of municipality total capital in 2008.

Column (5) reports spillover effects on neighbouring municipalities, defined as municipalities in the same communiting zone, excluding the focal municipality.

Standard errors clustered at the municipality level are in parentheses. * statistically significant at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level.

Source : German Social Security Records from the *Beschäftigtenhistorik* in Panels B and C. Bureau van Dijk Amadeus Database in Panel A.

Table 5: How Does Local Employment Adjust in Response to a Local Business Tax Increase?

Panel A: Employment, Hiring, and Separations

	(1) Employment	(2) Hiring	(3) Separations
Effects three years after tax change	-1.34***	-1.34***	0.01
	(0.21)	(0.37)	(0.49)

Panel B: Separations

	All separations	To non-employment	To employment
Effects three years after tax change	0.01	0.52***	-0.52
	(0.49)	(0.19)	(0.34)

Panel C: Hiring

	All hiring	From non-employment	From employment
Effects three years after tax change	-1.34***	-0.47**	-0.87***
	(0.37)	(0.23)	(0.29)

Panel D: Churning

	All churn	Job-to-job churn
Effects three years after tax change	-0.73**	-0.51***
	(0.30)	(0.20)

Notes: The table reports the effect of tax increases on job flows in the local municipality normalized by base year employment. Effects are measured three years after the tax change, scaled in percent, and can be interpreted as effects of a one-percentage-point increase in the local business tax rate. Column (1) in Panel A replicates the total employment effect from column (2) in Table 3. Standard errors clustered at the municipality level are in parentheses. Churning (Panel D) is the sum of separations in expanding establishments, hirings in contracting establishments, and separations (or hirings) in establishments in which employment remains constant,.
* statistically significant at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level.

Source : German Social Security Records from the *Beschäftigtenhistorik* (BEH).

Table 6: Effects of Business Taxation on Incumbent Workers

Panel A: Job Mobility

	Employer Change (0/1)	Number of Employers	Upward moves, defined by … … establishment fixed effect	… wage
Effects three years after tax change	-0.0098*	-0.0120*	-0.0081**	-0.0114**
	(0.0051)	(0.0064)	(0.0035)	(0.0048)

Panel B: Wage Changes Within and Between Establishments (Log Wage Change * 100)

	Total Wage Change	Within-job (stayers)	Between-job (movers)	Share attributable to moving (i)	(ii)
Effects three years after tax change	-0.57***	-0.48***	-0.74***	16%	37%
	(0.16)	(0.13)	(0.26)		

Panel C: Wage Changes Within and Between Establishments, by Establishment AKM Fixed Effect and Age (Log Wage Change * 100, Three years after Tax Change)

	Total Wage Change	Within-job (stayers)	Between-job (movers)	Share attributable to moving (i)	(ii)
High-wage firm	-0.76***	-0.71***	-1.36***	7%	25%
	(0.20)	(0.18)	(0.46)		
Medium-wage firm	-0.50***	-0.39***	-0.84***	22%	39%
	(0.11)	(0.10)	(0.27)		
Low-wage firm	-0.95**	-0.29***	-1.82**	69%	79%
	(0.39)	(0.11)	(0.72)		
Low-wage firm, worker aged <30	-1.00	-0.08	-1.51**	92%	96%
	(0.61)	(0.18)	(0.75)		

Notes: The table reports worker-level effects of a tax increase on labor market outcomes for the sample of workers employed in the local economy in the year before the tax change. Effects are measured three years after the tax change and can be interpreted as effects of a one-percentage-point increase in the local business tax rate. Panel C shows separate effects by the AKM wage fixed effect group of the establishment in which workers are employed in the year before the tax change. AKM fixed effects are measured over a 7-year period prior to the tax change. The 'Share attributable to moving' captures the share of the wage effect due to effects of the business tax increase on both the probability of moving and the gains from moving to a new establishment (as opposed to the direct within-establishment wage of stayers). The shares in columns (i) and (ii) are computed by two alternative decompositions (see Appendix B.3 for details). Standard errors clustered at the municipality level are in parentheses. * statistically significant at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level.

Source : German Social Security Records from the *Beschäftigtenhistorik* (BEH).

Table 7: Heterogeneous Employment and Wage Responses to a Local Business Tax Increase among Continuing Establishments

Panel A: Effect on employment (in percent)

		by establishment wage fixed effect		
	all	Low	Medium	High
Effects three years after tax change	-0.82**	-0.74	-0.49	-1.38**
	(0.40)	(0.51)	(0.65)	(0.67)
Control group employment change	9.96	9.65	7.80	12.37

Panel B: Effect on log wage * 100

		by establishment wage fixed effect		
	all	Low	Medium	High
Effects three years after tax change	-0.33***	-0.19	-0.15	-0.76***
	(0.12)	(0.15)	(0.12)	(0.22)
Control group wage growth	4.64	5.09	4.29	3.93

Panel C: Effect on log capital * 100

		by capital-employment ratio	
	all	Low	High
Effects three years after tax change	-2.41**	-1.32	-3.65*
	(1.17)	(1.32)	(1.87)

Panel D: Effect on employment flows (high-wage establishments)

	Employment	Hirings	Separations	Churn
Effects three years after tax change	-1.38**	-1.76***	-0.26	-0.75*
	(0.67)	(0.67)	(0.51)	(0.39)

Notes : The table reports heterogeneous effects of tax increases on establishment-level total employment, average wages and total capital. Effects are measured three years after the tax change, scaled in percent, and can be interpreted as effects of a one-percentage-point increase in the local business tax rate. The first results column replicates the establishment-level effect from column 3 in Table 3. The remaining columns report heterogeneous effects by establishment wage fixed effect. Establishment wage fixed effects are estimated on a 7-year period prior to the tax change. Establishment wage fixed effect groups are defined to represent equally sized shares of employment. Standard errors clustered at the municipality level are in parentheses. * statistically significant at the 0.10 level, ** at the 0.05 level, *** at the 0.01 level.

Source : German Social Security Records from the *Beschäftigtenhistorik* (BEH).

The Effects of Business Taxation on Local Labor Markets, Firms and Workers' Careers

Online Appendix

Thomas Cornelissen, Mimosa Distefano, Christian Dustmann, Uta Schönberg

Appendix A: Data

Appendix A.1 Imputation of Censored Wage Observations

To impute top-coded wages, we split the sample into cells defined by the interaction of year, gender, education (no post-secondary education, vocational degree, college or university degree), broad age categories, and region (East or West Germany). Within each cell, following Dustmann et al. (2009) and Card et al. (2013), we estimate Tobit wage equations separately by year while controlling for age; firm size (quadratic, and a dummy for firm size greater than 10); occupation dummies; a worker's mean wage and mean censoring indicator (each computed over time but excluding observations from the current time period); and the establishment's mean wage, mean censoring indicator, mean years of schooling, and mean university degree indicator (each computed at the current time period by excluding the focal worker observations). For workers observed in only one time period, the mean wage and mean censoring indicator are set to sample means, and a dummy variable is included. A wage observation censored at value c is then imputed by the value $X\hat{\beta} + \hat{\sigma}\Phi^{-1}[k + u(1-k)]$, where Φ is the standard normal CDF, u is drawn from a uniform distribution, $k = \Phi[(c - X\hat{\beta})/\hat{\sigma}]$, and $\hat{\beta}$ and $\hat{\sigma}$ are estimates for the coefficients and standard deviation of the error term from the tobit regression.

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Card, David, Jörg Heining, and Patrick Kline. "Workplace heterogeneity and the rise of West German wage inequality." *Quarterly Journal of Economics* 128, no. 3 (2013): 967-1015.

Dustmann, Christian, Johannes Ludsteck, and Uta Schönberg. "Revisiting the German Wage Structure." *Quarterly Journal of Economics* 124, no. 2 (2009): 843–881.

Appendix A.2 Harmonization of Education and Full-Time Status

Education. The categorization of workers in education groups is performed by borrowing from Fitzenberger, Osikominu, and Völter (2006). In the first step, we group the original education variable into three categories: 1) low-skilled (no completion of high school or of an apprenticeship) 2) medium-skilled (completion of high school (Abitur) or an apprenticeship) 3) high-skilled (completion of a university degree). In the second step, missing values in the education variable are imputed for each worker-year observation using non-missing values of adjacent years. In the third step, we then assign one time-constant education category to each worker using the mode of the worker's imputed education observations.

Full-Time Status. The Social Security Records data provide an indicator of the worker's part-time or full-time status. In 2011, there was a change in the employers' reporting procedure that increased the share of missing observations of this indicator from less than 1% to 30% in the raw data (Fitzenberger and Seidlitz, 2020). The new reporting procedure also increased the share of workers reported in part-time work from 2012 onwards (Fitzenberger and Seidlitz, 2020). As the new reporting procedure made reporting part-time status more salient, some workers who reported working part-time after 2011 were incorrectly classified as working full-time before 2011. To correct this, we follow Fitzenberger and Seidlitz (2020) and estimate the probability of working part-time based on observable characteristics, such as the wage and sector of work, to reweight the potentially misreported full-time spells. This correction is performed separately for men and women, as a much larger share of women is employed part-time.

References:

Fitzenberger, B., Osikominu, A., and Völter, R. (2006). Imputation Rules to Improve the Education Variable in the IAB Employment Subsample. in *Schmollers Jahrbuch: J. Appl. Soc. Sci. Stud. / Zeitschrift für Wirtschafts- und Sozialwissenschaften*, 126(3), pp. 405-436

Fitzenberger, B., and Seidlitz, A. (2020). The 2011 break in the part-time indicator and the evolution of wage inequality in Germany. *Journal for Labour Market Research*, 54(1), 1-14.

Appendix A.3 Definition of Liable Establishments

While in principle, all firms with commercial activity are liable to the local business tax, regardless of whether they are incorporated or unincorporated, there are a few exceptions depending on industry affiliation and (in some cases) legal form, as laid out in Germany's Business Tax Code (Gewerbesteuergesetz (GewStG)). As the BEH does not include information on legal form, we proxy liability using the establishment's 5-digit industry affiliation (840 categories). We consider the following establishments as non-liable and drop them from our sample: establishments in the agriculture, farming, and forestry sectors; fisheries employing less than seven employees; liberal professionals such as lawyers, journalists, accountants, architects, researchers, artists, physicians; establishments in the public and education sectors; public and video libraries and museums.

Appendix A.4 Bureau van Dijk Data Sample

In addition to the sample restrictions imposed in the BEH social security data, we impose the following restrictions in the Bureau van Dijk data. First, we drop firms with more than 1,000 employees to lower the probability that a firm consists of multiple establishments in different municipalities, as we cannot correctly assign the local business tax rate for such firms. We further drop firms in the real estate sector, as these firms typically report unusually high value of assets simply because they own more buildings than firms in other sectors. We finally restrict the sample to firms with non-missing values for fixed assets. We further set negative values to fixed assets to zero and replace outlier observations of fixed assets (i.e., the top and bottom 1 percent) with the 1st and 99th percentile values.

Appendix B: Empirical Analysis

B.1 Decomposing the Local Employment Decline into Within-Establishment Declines and Establishment Entry and Exit (Figure 4)

Relative changes in local employment $E_{m,t}$ between period t and $t-g$ can be decomposed as follows:

$$\frac{E_{m,t}-E_{m,t-g}}{E_{m,t-g}} = \underbrace{\frac{E_{m,t-g}^{\text{con}}}{E_{m,t-g}}\frac{E_{m,t}^{\text{con}}-E_{m,t-g}^{\text{con}}}{E_{m,t-g}^{\text{con}}}}_{\substack{(1)\text{within}-\text{establishment}\\ \text{adjustments}}} + \underbrace{\frac{E_{m,t}^{\text{entry}}}{E_{m,t-g}}}_{\substack{\text{establishment}\\ \text{entry}}} + \underbrace{\frac{E_{m,t}^{\text{exit}}}{E_{m,t-g}}}_{\substack{\text{establishment}\\ \text{exit}}} + \underbrace{\frac{E_{m,t}^{\text{rel,entry}}-E_{m,t}^{\text{rel,exit}}}{E_{m,t-g}}}_{\text{relocation}},$$

where $E_{m,t}^{\text{con}}$is employment in continuing firms, $E_{m,t}^{\text{entry}}$ is employment in firms that newly entered the market, $E_{m,t}^{\text{exit}}$ is (the negative of) employment in firms that exited the market, $E_{m,t}^{\text{rel,entry}}$ is employment in firms that relocated into the municipality, and $E_{m,t}^{\text{rel,exit}}$ is employment in firms that relocated away from the municipality. The first component captures within-establishment employment adjustments. This term is equal to the product between the employment share of continuing firms in the base period ($\frac{E_{m,t-\tau}^{\text{con}}}{E_{m,t-\tau}}$) and employment changes within continuing establishments ($\frac{E_{m,t}^{\text{con}}-E_{m,t-\tau}^{\text{con}}}{E_{m,t-\tau}^{\text{con}}}$). The second and third terms capture local employment changes due to establishment entry and exit (i.e., the establishment identification number appears or disappears from the data base), while the fourth component captures local employment changes due to establishment relocation to another municipality (i.e., the establishment is located in a different municipality in period t than in period $t-\tau$).

In Panel A of Figure 4, we use the four components as dependent variables in regression equation (5) (first difference design). The coefficients add up to the total change in local employment following the business tax change from the first difference specification (i.e., column (4) in Table 3).

The change in local employment due to establishment exit, $\frac{E_{m,t}^{\text{exit}}}{E_{m,t-\tau}}$, can be decomposed into components representing different establishment types, such as low-, medium-, and high-paying establishments (or small, medium, and large establishments):

$$\frac{E_{m,t}^{\text{exit}}}{E_{m,t-\tau}} = \frac{E_{m,t-\tau}^{\text{Low}}}{E_{m,t-\tau}}\frac{E_{m,t}^{\text{Low,exit}}}{E_{m,t-\tau}^{\text{Low}}} + \frac{E_{m,t-\tau}^{\text{Medium}}}{E_{m,t-\tau}}\frac{E_{m,t}^{\text{Medium,exit}}}{E_{m,t-\tau}^{\text{Medium}}} + \frac{E_{m,t-\tau}^{\text{High}}}{E_{m,t-\tau}}\frac{E_{m,t}^{\text{High,exit}}}{E_{m,t-\tau}^{\text{High}}}.$$

In Panel B of Figure 4, we use the three components as dependent variables in regression equation (5) (difference design). The coefficients add up to the tax-induced decline in local employment attributable to establishment exit.

Appendix B.2 Decomposing the Local Employment Decline into Hiring and Separations (Table 5)

Changes in local employment between period t and $t-\tau$ can be decomposed as follows:

$$\frac{E_{m,t}-E_{m,t-\tau}}{E_{m,t-\tau}}=\underbrace{\frac{\text{Hires}_{m,(t-\tau,t)}}{E_{m,t-\tau}}}_{\text{hiring rate}}-\underbrace{\frac{\text{Sep}_{m,(t-\tau,t)}}{E_{m,t-\tau}}}_{\text{separation rate}}.$$

where $\text{Hires}_{m,(t-\tau,t)}$ denote the number of employees who were hired between $t-\tau$ and t by one of the establishments in the municipality and $\text{Sep}_{m,(t-\tau,t)}$ denote the number of employees who separated from one of the establishments in the municipality between $t-\tau$ and t.[1]

In row (i) of Panel A of Table 5, we use the hiring and separation rate as dependent variables in the difference design given by regression equation (5), focusing on effects three years after the tax change. The coefficients add up to the total tax-induced employment decline in the municipality obtained from the difference design.

In row (ii), we break down hires and separations into hires from employment and non-employment, depending on workers' labor market status in $t-\tau$ and t, respectively. In row (iii), we also break down hires and separations from employment into whether the hire is from (or the separation is to) an establishment in the same or in different commuting zone, depending on where workers were or are employed in periods $t-\tau$ and t, respectively.

Appendix B.3 Decomposing Individual Wage Growth into Within- and Between-Establishment Components (Panels B and C of Table 6)

Expected wage growth in group G (with G=T for the treatment group and G=C for the control group) can be written as a weighted average of the wage growth of stayers and movers:

$$\text{E}[\Delta \text{w}^G] = (1-\text{Pr(move)}^G)\text{E}[\Delta \text{w}^G|\text{stay}] + \text{Pr(move)}^G\,\text{E}[\Delta \text{w}^G|\text{move}]. \qquad \text{(B.1)}$$

Taking the difference between treatment and control group, this yields:

[1] Workers who switch between establishments in the municipality count as both hires and separations and leave total employment in the municipality unchanged.

$$\mathrm{E}[\Delta \mathrm{w}^T] - \mathrm{E}[\Delta \mathrm{w}^C]$$

$$= \underbrace{(1 - \Pr(\text{move})^C)(\mathrm{E}[\Delta \mathrm{w}^T|\text{stay}] - \mathrm{E}[\Delta \mathrm{w}^C|\text{stay}])}_{\text{Term A: change of within-job wage growth}}$$

$$+ \underbrace{\Pr(\text{move})^C\,(\mathrm{E}[\Delta \mathrm{w}^T|\text{move}] - \mathrm{E}[\Delta \mathrm{w}^C|\text{move}])}_{\text{Term B: change of wage growth for movers}}$$

$$+ \underbrace{(\Pr(\text{move})^T - \Pr(\text{move})^C)(\mathrm{E}[\Delta \mathrm{w}^T|\text{move}] - \mathrm{E}[\Delta \mathrm{w}^T|\text{stay}])}_{\text{Term C: change of the probability of moving}} \qquad \text{(B.2)}$$

Equation (B.2) thus allows decomposing the wage effect of a tax increase into a part driven by changed within-job wage growth for stayers weighted with the probability of staying (Term A), changed wage growth for movers weighted with the probability of moving (Term B), and a changed probability of moving weighted with the gains from moving.

Equation (B.1) can be re-written as

$$\mathrm{E}[\Delta \mathrm{w}^G] = \mathrm{E}[\Delta \mathrm{w}^G|\text{stay}] + \Pr(\text{move})^G\,(\mathrm{E}[\Delta \mathrm{w}^G|\text{move}] - \mathrm{E}[\Delta \mathrm{w}^G|\text{stay}]), \qquad \text{(B.3)}$$

motivating the different decomposition of

$$\mathrm{E}[\Delta \mathrm{w}^T] - \mathrm{E}[\Delta \mathrm{w}^C]$$

$$= \underbrace{\mathrm{E}[\Delta \mathrm{w}^T|\text{stay}] - \mathrm{E}[\Delta \mathrm{w}^C|\text{stay}]}_{\text{Term A: change of within-job wage growth}}$$

$$+ \underbrace{\Pr(\text{move})^C\,[(\mathrm{E}[\Delta \mathrm{w}^T|\text{move}] - \mathrm{E}[\Delta \mathrm{w}^T|\text{stay}]) - (\mathrm{E}[\Delta \mathrm{w}^C|\text{move}] - \mathrm{E}[\Delta \mathrm{w}^C|\text{stay}])]}_{\text{Term B: change of wage growth for movers}}$$

$$+ \underbrace{(\Pr(\text{move})^T - \Pr(\text{move})^C)(\mathrm{E}[\Delta \mathrm{w}^T|\text{move}] - \mathrm{E}[\Delta \mathrm{w}^T|\text{stay}])}_{\text{Term C: change of the probability of moving}}. \qquad \text{(B.4)}$$

One key difference compared to (B.2) is that in (B.4) the change in wage growth for movers in Term B is evaluated relative to the change in wage growth for stayers. That is, Term B in (B.4) involves a counterfactual comparison, evaluating the return to moving relative to the wage growth of stayers. Equation (B.2) on the other hand (which is equivalent to equation (8) in Autor and Dube, 2023) is more descriptive and does not evaluate the wage growth of movers relative to that of stayers.

Equation (B.4) apportions less of the wage effect of tax changes onto Term B (changes in the returns to moving) than (B.2), and more of it to Term A (direct effect on within-job wage growth). As it is unclear what the correct counterfactual is, we report results from both decompositions.

Dividing (B.2) and (B.4) through by their left-hand side yields the relative contributions of each term to the total wage effect:

$$1 = \underbrace{\frac{(\mathrm{E}[\Delta \mathrm{w}^T|\mathrm{stay}] - \mathrm{E}[\Delta \mathrm{w}^C|\mathrm{stay}])\,(1 - \Pr(\mathrm{move})^C)}{\mathrm{E}[\Delta \mathrm{w}^T] - \mathrm{E}[\Delta \mathrm{w}^C]}}_{\text{Term A: change of within-job wage growth}} + \underbrace{\frac{(\mathrm{E}[\Delta \mathrm{w}^T|\mathrm{move}] - \mathrm{E}[\Delta \mathrm{w}^C|\mathrm{move}])\,\Pr(\mathrm{move})^C}{\mathrm{E}[\Delta \mathrm{w}^T] - \mathrm{E}[\Delta \mathrm{w}^C]}}_{\text{Term B: change of wage growth for movers}} + \underbrace{\frac{(\Pr(\mathrm{move})^T - \Pr(\mathrm{move})^C)(\mathrm{E}[\Delta \mathrm{w}^T|\mathrm{move}] - \mathrm{E}[\Delta \mathrm{w}^T|\mathrm{stay}])}{\mathrm{E}[\Delta \mathrm{w}^T] - \mathrm{E}[\Delta \mathrm{w}^C]}}_{\text{Term C: change of the probabiliy of moving}}$$

and

$$1 = \underbrace{\frac{\mathrm{E}[\Delta \mathrm{w}^T|\mathrm{stay}] - \mathrm{E}[\Delta \mathrm{w}^C|\mathrm{stay}]}{\mathrm{E}[\Delta \mathrm{w}^T] - \mathrm{E}[\Delta \mathrm{w}^C]}}_{\text{Term A: change of within-job wage growth}} + \underbrace{\frac{\Pr(\mathrm{move})^C\,[(\mathrm{E}[\Delta \mathrm{w}^T|\mathrm{move}] - \mathrm{E}[\Delta \mathrm{w}^T|\mathrm{stay}]) - (\mathrm{E}[\Delta \mathrm{w}^C|\mathrm{move}] - \mathrm{E}[\Delta \mathrm{w}^C|\mathrm{stay}])]}{\mathrm{E}[\Delta \mathrm{w}^T] - \mathrm{E}[\Delta \mathrm{w}^C]}}_{\text{Term B: change of wage growth for movers}} + \underbrace{\frac{(\Pr(\mathrm{move})^T - \Pr(\mathrm{move})^C)(\mathrm{E}[\Delta \mathrm{w}^T|\mathrm{move}] - \mathrm{E}[\Delta \mathrm{w}^T|\mathrm{stay}])}{\mathrm{E}[\Delta \mathrm{w}^T] - \mathrm{E}[\Delta \mathrm{w}^C]}}_{\text{Term C: change of the probabiliy of moving}}.$$

Thus, the relative contribution of reduced returns to, and reduced probability of, mobility (Terms B and C) is equal to one minus the relative contribution of Term A:

$$1 - \frac{(\mathrm{E}[\Delta \mathrm{w}^T|\mathrm{stay}] - \mathrm{E}[\Delta \mathrm{w}^C|\mathrm{stay}])(1 - \Pr(\mathrm{move})^C)}{\mathrm{E}[\Delta \mathrm{w}^T] - \mathrm{E}[\Delta \mathrm{w}^C]} \qquad \text{(B.5)}$$

$$1 - \frac{(\mathrm{E}[\Delta \mathrm{w}^T|\mathrm{stay}] - \mathrm{E}[\Delta \mathrm{w}^C|\mathrm{stay}])}{\mathrm{E}[\Delta \mathrm{w}^T] - \mathrm{E}[\Delta \mathrm{w}^C]} \qquad \text{(B.6)}$$

These are the two shares attributable to moving that we report in Table 6, where $\mathrm{E}[\Delta \mathrm{w}^T] - \mathrm{E}[\Delta \mathrm{w}^C]$ is the total wage effect and $\mathrm{E}[\Delta \mathrm{w}^T|\mathrm{stay}] - \mathrm{E}[\Delta \mathrm{w}^C|\mathrm{stay}]$ is the within-job wage effect reported in Table 6, and $\Pr(\mathrm{move})^C$ is the job change probability between the year before the tax change and three years after the tax change.[2] For example, for the overall sample, based on

[2] In the overall sample, we find $\Pr(\mathrm{move})^C = 0.256$, for workers in low-wage, medium-wage, and high-wage firms before the tax change we find values of 0.316, 0.217, and 0.198, respectively, for workers aged <30 in low-wage firms the value is 0.484.

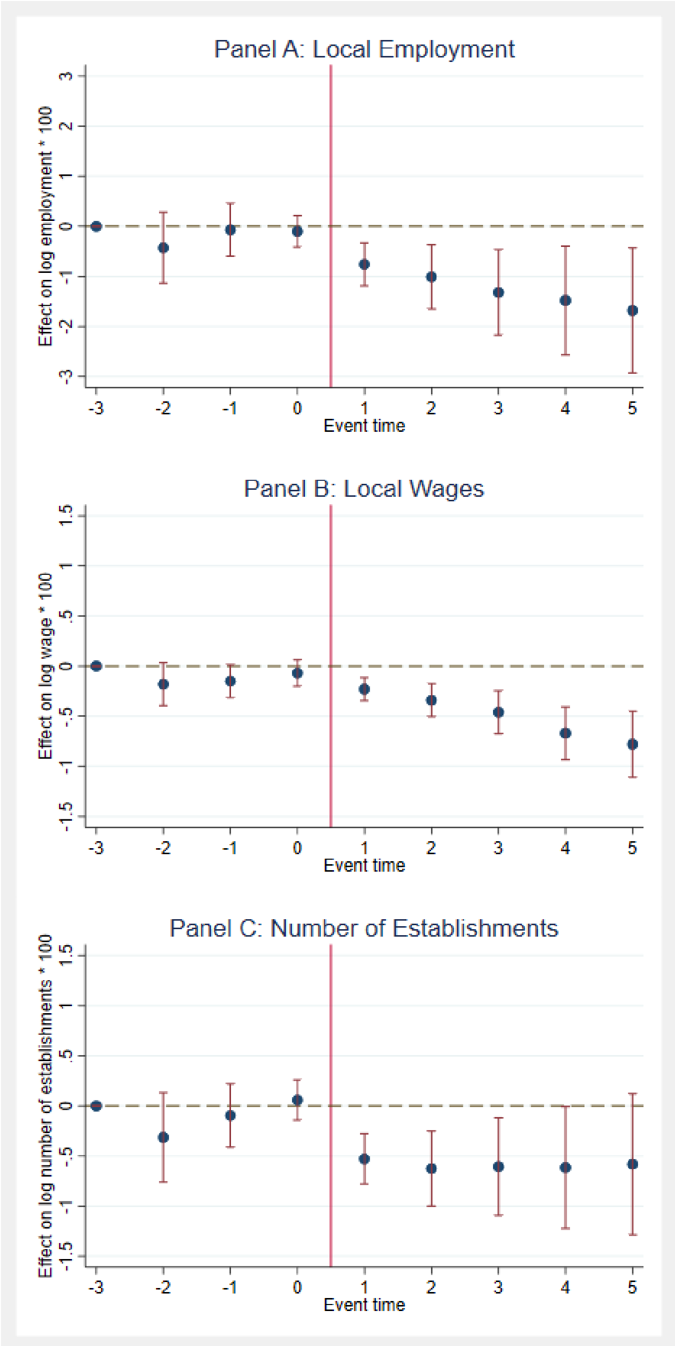
(B.5) we obtain $1 - \frac{-0.48(1-0.256)}{-0.57} = 1 - \frac{-0.48(1-0.256)}{-0.57} = 0.37$ (see column (ii) in Panel B, Table 6) and based on (B.6) we obtain $1 - \frac{-0.48}{-0.57} = 0.16$ (see column (i) in Panel B, Table 6). Moreover, because the effect of a tax change on the average probability of moving is very small ($\Pr(\text{move})^T - \Pr(\text{move})^C = -0.0098$, see Panel A of Table 6), the contribution of Term C is be very small, meaning that the share attributable to moving is almost mostly driven by reduced returns to moving (Term B).

Reference:

Autor, D., Dube, A., & McGrew, A. (2023). The unexpected compression: Competition at work in the low wage labor market (No. w31010). National Bureau of Economic Research.

Appendix C: Robustness of Event Study Design

Figure C.1: Robustness of Effects of Business Taxation on Wages, Employment, and Number of Establishments



Notes: The figure shows event-study effects estimated following Borusyak, Jaravel, and Spiess ("BJS", 2021) on wages, employment, and the number of establishments. Compared with our baseline estimates in Figures 2 and 3, we should note that pre-trends are differently normalized (relative to period 0 in our baseline approach and to prior pre-periods in the BJS method). A similar caveat holds for the post-event treatment effects, which in our baseline approach are estimated relative to period 0 and in the BJS method relative to the entire pre-period. 95%-confidence intervals are based on standard errors clustered at the municipality level.
Source: German Social Security Records from the Beschäftigtenhistorik (BEH).

Appendix D: Model

D.1 Model Overview

Consider a local economy m with homogeneous workers, heterogeneous firms, and an effective local business tax rate of τ^m. We take the initial location choices of workers and firms as given and focus on the effects of an increase in the local business tax rate on workers' employment decisions in the local economy, on firms' decisions to exit the local economy, and on labor and capital choices of surviving firms.

Production Function and Firms' Profits. Firms (indexed by j) use capital k and labor l to produce output according to a CES production function with constant returns to scale and a firm-level elasticity of substitution between labor and capital $\sigma = \frac{1}{1-\nu}$:

$$y_j = F_j(k_j, l_j) = [l_j^\nu + (\theta_j k_j)^\nu]^{\frac{1}{\nu}}.$$

The firm-specific capital-augmenting productivity shifter θ_j makes firms heterogeneous in their productivity. Firms' profits are as defined in section 2.2, where we highlighted that an increase in the local business tax rate τ^m raises the effective cost of capital (equation (3)).

Monopolistic Product Market. Firms produce differentiated varieties of consumption goods which are substitutes in consumers preferences ($\eta > 1$ where η denotes the elasticity of substitution between any two goods; see Appendix Section D.2 for details). The higher the elasticity of substitution between goods, the more competitive the product market and the lower the markup a firm can charge.

Monopsonistic Local Labor Markets. Workers first decide whether to work in the local economy m or not (not working in m may either reflect working elsewhere or not working at all). This decision depends on the local market wage, the outside option, and workers' idiosyncratic preferences for the outside option versus the local economy. Such preferences ensure that some workers will work in the local economy even though wages in other local economies may be higher. We assume the outside option is unaffected by the local business tax rate.

In a second step, and conditionally on working in the local economy, they decide which firm to work for, choosing the firm within the local labor market that provides them with the highest utility. They derive utility from wages and idiosyncratic job characteristics, such as commuting time, how well workers get along with their co-workers or bosses, or their preferences for the firm's working schedule. These non-pecuniary job characteristics imply that firms face an upward-sloping labor supply curve. We denote the labor supply elasticity to the firm by *b* (see Appendix Section D.2 for details).

Perfectly competitive capital markets. We assume that capital supply to the local economy is infinitely elastic. Consequently, the interest rate *r* is determined in national or worldwide capital markets and unaffected by the local business tax rate.

Equilibrium Properties. Under the conditions outlined in Proposition 1 in Appendix Section D.3, firms with a higher productivity θ_j earn higher profits, are more likely to operate in the market, are larger, pay higher wages, and are more capital intensive. The result that larger firms are more capital-intensive is in line with the empirical evidence (e.g., Abowd, Kramarz, and Margolis, 1999; Oi and Idson, 1999; Arai, 2003).

D.1.1 The Effects of a Business Tax Rate Increase on Firms and the Local Labor Markets

We now consider a municipality that increases its business tax rate τ^m and ask how this affects firms' entry and exit decisions, their labor demand and wage offers, and wages and employment in the local labor market.

Firm Exit. An increase in the business tax rate induces firms with the lowest values of the productivity parameter θ_j to exit the market, as the tax increase reduces firms' profits, and low-productivity firms will no longer find it profitable to operate in the market (see Proposition 2 in Appendix Section D.4). Since, as outlined above, these firms are small and pay low wages, firm exit following a business tax increase will be driven by small and low-paying firms.

Firms' Labor Demand and Wage Offers Holding Local Wages and Labor Supply constant. As firms can only deduct part of their capital costs from their profits, an increase in the business tax rate increases the effective cost of capital, $R = r\frac{1-\beta\tau^m}{1-\tau^m}$. As shown in Appendix D.5, the increase in the effective cost of capital will reduce firms' capital stocks. The direction of the within-firm employment and wage adjustment depends on whether goods or factor inputs are more substitutable ($\eta \lesseqgtr \sigma$). On the one hand, firms would like to replace capital with labor as capital becomes more expensive—and their ability to do so depends on the elasticity of substitution between capital and labor, σ (a substitution effect). On the other hand, firms' costs increase following a business tax increase, inducing firms to scale down their production (a scale effect). The scale effect will depend on firms' ability to raise product prices in response to the business tax increase—which is greater when the elasticity of substitution between goods, η, is low. If the scale effect dominates the substitution effect ($\eta > \sigma$), an increase in the effective cost of capital will reduce firms' employment and wages.

Moreover, the model predicts that within-firm capital, employment, and wage adjustments are generally more pronounced in larger capital-intensive firms that pay higher wages. Finally, the firm's capital response should exceed its employment response to a business tax increase (see Proposition 3 in Appendix Section D.5 for more details).

Capital, Employment, and Wages in the Local Economy. Since a rise in the local business tax increases firm exit and leads to declines in capital, employment, and wages among surviving firms (if $\eta > \sigma$), the capital stock, employment, and wages will decline in the local economy. The decline in aggregate wages will reduce labor supply to the local labor market in accordance with the local labor supply elasticity δ. In equilibrium, firms will take this into account, but as we show in Appendix D.6, this does not change the sign of the aggregate effects on capital, employment, and wages. The decline in local employment will be more substantial, and the reduction in local wages will be smaller if the combined labor supply elasticity to the local labor market and the firm, δb, is larger. The exact size of the local employment and wage decline will additionally depend on the distribution of firm types (i.e., the distribution from which θ is drawn).

Elasticity of Substitution between Capital and Labor. The model implies that the elasticity of substitution between labor and capital can be identified by combining our empirical results with an expression on the effective cost of capital that we can derive under plausible assumptions. Our estimated capital, employment and wage effects of a business tax change imply an elasticity of substitution of $\sigma = 0.85$ (see Appendix D.8 for detail).

D.2 Details of Model Set-up

Product Markets. The preferences of a representative consumer are given by a CES utility function over goods (indexed here by j as we assume that each firm produces a different variety):

$$U = \left(\sum_{j \epsilon J} y_j^{\rho}\right)^{\frac{1}{\rho}},$$

where $\frac{1}{1-\rho} \coloneqq \eta$ is the elasticity of substitution between any two goods and J denotes the set of all firms producing goods to which consumers have access (which is, as goods are traded in national or international markets, larger than the set of firms operating in the local market). We assume that goods are substitutes (i.e., $\eta > 1$). As was originally shown by Dixit and Stiglitz (1977) for the case of a continuum of goods, and assuming that there are many firms operating in the market, the optimal demand for a good produced by firm j can be approximated as:

$$y_j = Y\left(\frac{p_j}{P}\right)^{-\eta}$$

where $P = \left(\sum_{k \epsilon J} p_k^{1-\eta}\right)^{\frac{1}{1-\eta}}$ is the aggregate price index, Y is aggregate output and p_j is the price charged by firm j. We assume that the aggregate product price P is determined in national or international markets and is unaffected by a local business tax increase.

Monopsonistic Labor Markets.

Choice of firm conditional on employment in the local labor market. The indirect utility of worker i working at firm j is

$$\mathrm{u}_{ij} = b \log w_j + e_{ij}$$

where $\log w_j$ is the (log) wage that firm j pays to all its workers, e_{ij} denotes her idiosyncratic preferences for working at the firm, and b is a preference parameter that will translate into the labor supply elasticity to the firm (conditional on labor supply to the local economy). Conditional on working in the local economy, and assuming that e_{ij} are independent draws from a type I Extreme Value distribution with scale parameter 1, the probability that a worker chooses to work for firm j equals (McFadden, 1977):

$$P\left(\arg\max_{j' \in J^m}\{\mathrm{u}_{ij'}\} = j\right) = \frac{\exp\{b \log w_j\}}{\sum_{j' \epsilon J^m} \exp\{b \log w_{j'}\}} = \frac{w_j^b}{W^m}$$

where J^m denotes the number of firms operating in the local market m, and $W^m := \sum_{j' \epsilon J^m} \exp\{b \log w_{j'}\}$ captures aggregate wages in the local economy (which we will refer to as the "market wage"). This implies a labor supply curve to firm j of

$$l_j = L^{Sm} P\left(\arg\max_{j' \epsilon J^m}\{\mathrm{u}_{ij'}\} = j\right) = L^{Sm} \frac{w_j^b}{W^m} \qquad (D.1)$$

Decision to work in the local labor market. Assume that workers derive utility

$$\mathrm{u}_{iO} = \log O + \xi_{iO}$$

from working in another local labor market or from non-employment, where we can think of O as workers' outside option and ξ_{iO} as capturing workers' preferences for that outside option. Assuming that ξ_{iO} is drawn from an extreme value distribution with scale parameter $\lambda > 0$, workers' labor supply to the local economy is given by

$$L^{Sm} = N^m \frac{\exp\left(\log W^m / \lambda\right)}{\exp(\log O / \lambda) + \exp\left(\log W^m / \lambda\right)}$$

where N^m denotes the pool of workers who could potentially work in the local economy, which is exogenously given.

D.3 Effects of θ on Firm Profits, Employment, Wages, and Capital Intensity

Effects of θ on profits. Re-normalized firm profits are given by $\Pi_j = \frac{\pi_j}{(1-\tau^m)} = p_j y_j - w_j l_j - Rk_j - C$ with $R = r\frac{1-\beta\tau^m}{1-\tau^m}$. Substituting in the inverse demand function for the firm's output $p_j = \left(\frac{P}{Y}\right)^{-\frac{1}{\eta}} y_j^{-\frac{1}{\eta}} := P' y_j^{-\frac{1}{\eta}}$, the inverse labor supply curve to the firm $w_j = l_j^{\frac{1}{b}}(L^{Sm})^{-\frac{1}{b}}(W^m)^{\frac{1}{b}}$, and the production function $y_j = F_j(k_j, l_j)$ yields

$$\Pi_j = P' F_j(k_j, l_j)^{\frac{\eta-1}{\eta}} - l_j^{\frac{b+1}{b}}(L^{Sm})^{-\frac{1}{b}}(W^m)^{\frac{1}{b}} - Rk_j - C. \qquad (D.2)$$

Let k_j^* and l_j^* be the firm's profit-maximising input choices of labor and capital. Optimal profits are thus equal to:

$$\Pi_j(k_j^*, l_j^*) = P' F_j(k_j^*, l_j^*)^{\frac{\eta-1}{\eta}} - l_j^{*\frac{b+1}{b}}(L^{Sm})^{-\frac{1}{b}}(W^m)^{\frac{1}{b}} - Rk_j^* - C \qquad (D.3)$$

Because $\frac{\partial \log F_j(k_j, l_j)}{\partial \log \theta_j} = \frac{(\theta_j k_j)^\nu}{(\theta_j k_j)^\nu + l_j^\nu} := s_j > 0$, and assuming $\eta > 1$, an increase in θ_j holding l_j^* and k_j^* constant, unambiguously increases profits, $\frac{\partial \Pi_j(k_j^*, l_j^*)}{\partial \theta_j} > 0$, as it increases revenue but does not affect cost. The profit-maximising firm would only choose to further adjust l_j^* and k_j^* if this would lead to an additional profit increase. Therefore $\frac{d\Pi_j(k_j^*, l_j^*)}{d\theta_j} > 0$, and optimal profits are increasing in θ_j. Thus, firms with a higher productivity parameter θ will have higher profits and be more likely to operate in the market.

Effect of θ on employment, wages, and capital intensity. The profit function (D.2) yields first-order conditions for labor and capital given by (where we suppress j subscripts for clarity)

$$P' \frac{\eta - 1}{\eta} F(k, l)^{-\frac{1}{\eta}} F_L(k, l) - \frac{b+1}{b} l^{\frac{1}{b}} (L^{Sm})^{-\frac{1}{b}} (W^m)^{\frac{1}{b}} = 0.$$

$$P' \frac{\eta - 1}{\eta} F(k, l)^{-\frac{1}{\eta}} F_K(k, l) - R = 0.$$

Substituting in $F_K(k,l) = \frac{\partial F(k,l)}{\partial k} = \theta^{\frac{\sigma-1}{\sigma}} k^{-\frac{1}{\sigma}} F(k,l)^{\frac{1}{\sigma}}$ and $F_L(k,l) = \frac{\partial F(k,l)}{\partial l} = l^{-\frac{1}{\sigma}} F(k,l)^{\frac{1}{\sigma}}$, and taking logs yields:

$$FOC_L = \left(\frac{1}{\sigma} + \frac{1}{b}\right) \log l - \frac{1}{b} \log L^{Sm} + \frac{1}{b} \log W^m - \log \frac{b}{b+1} - \log\left(1 - \frac{1}{\eta}\right) - \log P' - \left(\frac{1}{\sigma} - \frac{1}{\eta}\right) \log F(k,l) = 0.$$

$$FOC_K = \frac{1}{\sigma} \log k + \log R - \frac{\sigma - 1}{\sigma} \log \theta - \log\left(1 - \frac{1}{\eta}\right) - \log P' - \left(\frac{1}{\sigma} - \frac{1}{\eta}\right) \log F(k,l) = 0.$$

The total differential for this system of equations is:

$$\begin{bmatrix} \frac{\partial FOC_L}{\partial \log l} & \frac{\partial FOC_L}{\partial \log k} \\ \frac{\partial FOC_K}{\partial \log l} & \frac{\partial FOC_K}{\partial \log k} \end{bmatrix} \begin{bmatrix} d \log l \\ d \log k \end{bmatrix} = \begin{bmatrix} -\frac{\partial FOC_L}{\partial \log P'} d \log P' - \frac{\partial FOC_L}{\partial \log L^{Sm}} d \log L^{Sm} - \frac{\partial FOC_L}{\partial \log W^m} d \log W^m - \frac{\partial FOC_L}{\partial \log \theta} d \log \theta \\ -\frac{\partial FOC_K}{\partial \log P'} d \log P' - \frac{\partial FOC_K}{\partial \log R} d \log R - \frac{\partial FOC_K}{\partial \log \theta} d \log \theta \end{bmatrix} \quad (D.4)$$

with

$$\frac{\partial FOC_L}{\partial \log l} = \left(\frac{1}{b} + \frac{1}{\eta}\right) + \left(\frac{1}{\sigma} - \frac{1}{\eta}\right) s,$$

$$\frac{\partial FOC_L}{\partial \log k} = -\left(\frac{1}{\sigma} - \frac{1}{\eta}\right) s,$$

$$\frac{\partial FOC_L}{\partial \log P'} = -1,$$

$$\frac{\partial FOC_L}{\partial \log L^{Sm}} = -\frac{1}{b},$$

$$\frac{\partial FOC_L}{\partial \log W^m} = \frac{1}{b},$$

$$\frac{\partial FOC_L}{\partial \log \theta} = -\left(\frac{1}{\sigma} - \frac{1}{\eta}\right) s,$$

$$\frac{\partial FOC_K}{\partial \log l} = -\left(\frac{1}{\sigma} - \frac{1}{\eta}\right) (1 - s),$$

$$\frac{\partial FOC_K}{\partial \log k} = \frac{1}{\sigma} - \left(\frac{1}{\sigma} - \frac{1}{\eta}\right) s,$$

$$\frac{\partial FOC_K}{\partial \log P'} = -1,$$

$$\frac{\partial FOC_L}{\partial \log R} = 1,$$

and

$$\frac{\partial FOC_K}{\partial \log \theta} = -\frac{\sigma - 1}{\sigma} - \left(\frac{1}{\sigma} - \frac{1}{\eta}\right) s,$$

and where we used

$$\frac{\partial \log F(k,l)}{\partial \log k} = \frac{(\theta k)^\nu}{(\theta k)^\nu + l^\nu} := s$$

and

$$\frac{\partial \log F(k,l)}{\partial \log l} = \frac{l^\nu}{(\theta k)^\nu + l^\nu} = 1 - s.$$

s can be interpreted as the input share of capital efficiency units, and $1 - s$ as the input share of labor efficiency units.

Solving system (D.4) for $\begin{bmatrix} d \log l \\ d \log k \end{bmatrix}$ allows us to derive comparative statics with respect to θ. This yields:

$$\frac{d \log l}{d \log \theta} = \frac{(\eta - \sigma) bs}{\eta(1 - s) + s\sigma + b}$$

$$\frac{d \log w}{d \log \theta} = \frac{d \log w}{d \log l} \frac{d \log l}{d \log \theta} = \frac{1}{b} \frac{d \log l}{d \log \theta} = \frac{(\eta - \sigma) s}{\eta(1 - s) + s\sigma + b}$$

Because $\eta > 0$, $\sigma > 0$, $b > 0$, and $s \in [0,1]$, it follows that if $\eta > \sigma$, $d \log l / d\theta > 0$ and $d \log w / d\theta > 0$. Thus, under these conditions, firms with higher with higher productivity parameter θ will be larger and pay higher wages.

We also get:

$$\frac{d\log k}{d\log\theta}=\frac{(b+1)s(\eta-\sigma)+(\sigma-1)(b+\eta)}{\eta(1-s)+s\sigma+b},$$

$$\frac{d\log k}{d\log\theta}-\frac{d\log l}{d\log\theta}=\frac{s(\eta-\sigma)+(\sigma-1)(b+\eta)}{\eta(1-s)+s\sigma+b},$$

$$\frac{ds}{d\theta}=\frac{\sigma-1}{\sigma}s^2\theta^{-\nu}\left(\frac{k}{l}\right)^{-\nu}\left[\left(\frac{k}{l}\right)^{-1}\frac{d(k/l)}{d\theta}+\theta^{-1}\right].$$ [3]

Thus, if $\eta > \sigma$ and $\sigma > 1$, firms with higher productivity parameter θ will employ more capital, will be more capital intensive, and will have a higher input share of capital efficiency units $\left(s=\frac{(\theta k)^{\nu}}{(\theta k)^{\nu}+l^{\nu}}\right)$. [4]

To summarize, under the conditions outlined in Proposition 1 below, firms with a higher productivity parameter θ_j earn higher profits, are more likely to operate in the market, are larger, pay higher wages, and are more capital intensive.

Proposition 1: Effects of θ on firm profits, employment, wages, and capital intensity.

a) $d\Pi_j/d\theta_j > 0$. Profits are increasing in productivity. Therefore, only firms with $\theta_j > \theta^*$ will operate in the market where $\Pi(\theta^*) = 0$.

b) If $\eta > \sigma$, it follows that $d\log l_j/d\log\,\theta_j > 0$ and $d\log\,w_j/d\log\,\theta_j > 0$. Firms with a higher productivity parameter θ_j will employ more workers and pay higher wages.

c) If $\eta > \sigma$ and $\sigma > 1$, it follows that firms with a higher productivity parameter θ_j will employ more capital (i.e., $d\,\log k_j/d\log\,\theta_j > 0$), be more capital-intensive

[3] Due to $\frac{d\log k}{d\log\theta}-\frac{d\log l}{d\log\theta}=\frac{d(\log k-\log l)}{d\log\theta}=\frac{d\log k/l}{d\log\theta}$, the term $\frac{d(k/l)}{d\theta}$ has the same sign as $\frac{d\log k}{d\log\theta}-\frac{d\log l}{d\log\theta}$.

[4] The production function with a capital-augmenting productivity shifter θ_j can account for the empirical regularity that larger firms pay higher wages and are more capital-intensive, provided that $\sigma > 1$. A production function with a labor-augmenting productivity shifter θ_j is also able to replicate positive correlations between wages, firm size and capital intensity, provided that $\sigma < 1$. The two production functions, with opposite assumptions about $\sigma \lesseqgtr 1$, are largely equivalent and both lead to propositions 1 to 4 for moderately large η. For our purposes, it is important that the model is able to replicate the empirical regularity that larger and higher-paying firms are more capital-intensive; it is not important whether this is because the productivity shifter is capital-augmenting and $\sigma > 1$ or labor-augmenting and $\sigma < 1$. If $\sigma < 1$, capital and labor will be gross complements. If, in contrast, $\sigma > 1$, capital and labor will be gross substitutes (see e.g., Acemoglu, 2002).

(i.e., $d\ \log k_j/d\log\ \theta_j - d\ \log l_j/d\log\ \theta_j > 0$) and have a higher share of capital efficiency units (i.e., $ds_j/d\theta_j > 0$, with $s_j = \frac{(\theta_j k_j)^\nu}{(\theta_j k_j)^\nu + l_j^\nu}$).

D.4 Effects of Local Taxes τ^m on Firm Profits and Exit

The tax rate τ^m affects firm outcomes via the effective cost of capital $R = r\frac{1-\beta\tau^m}{1-\tau^m}$ with $\frac{dR}{d\tau^m} = r\frac{1-\beta}{(1-\tau^m)^2} > 0$. That is, a rise in the tax rate τ^m increases the effective cost of capital R. We therefore derive the effect of tax changes by doing comparative statics with respect to R.

Consider the profit function at optimal input choices given by (D.3). If the firm holds capital and labor inputs constant, then a rise in R merely increases cost but does not affect revenue, and therefore unambiguously reduces profits. Any adjustments in capital and labor in response can at most partly offset the reduction in profits, but can never lead to higher profits than before, because otherwise the firm would not have maximized its profits prior to the increase in R. Therefore $\frac{d\Pi(k_j^*, l_j^*)}{dR} < 0$; profits at optimal labor and capital inputs are decreasing in R (and therefore also in the tax rate τ^m).

The threshold θ^* that makes a firm just indifferent to participation is implicitly defined as the value of θ_j that solves $\Pi\left(k_j^*, l_j^*\right) = 0$, where $\Pi\left(k_j^*, l_j^*\right)$ is given in (D.3).[5] The effect of R on θ^* is given by implicit differentiation as:

$$\frac{d\theta^*}{dR} = -\frac{\frac{\partial \Pi\left(k_j^*, l_j^*\right)}{\partial R}}{\frac{\partial \Pi\left(k_j^*, l_j^*\right)}{\partial \theta}},$$

since the partial derivatives of Π with respect to k and l vanish at k^* and l^*. Given $\frac{\partial\Pi(k_j^*, l_j^*)}{\partial R} = -k_j < 0$ and $\frac{\partial\Pi(k_j^*, l_j^*)}{\partial\theta_j} > 0$ (as shown in Appendix D.1 under the assumption $\eta > 1$), we get that $\frac{d\theta^*}{dR} > 0$. A rise in the cost of capital (as a result of a rise in the tax rate τ^m) therefore

[5] $\Pi\left(k_j^*, l_j^*\right)$ in equation D.3 depends implicitly on θ_j through optimal capital and labor choices l_j^* and k_j^* and through the occurrence of θ_j as technology factor in the production function.

increases the participation threshold θ^*, driving low-productivity firms out of business. We summarize these results in proposition 2:

Proposition 2: $\frac{d\theta^*}{d\tau^m} > 0$. Firms with the lowest productivity parameter θ_j—that is, smaller and lower-paying firms—exit the market.

D.5 Effects of Local Taxes τ^m on Firm Capital, Employment and Wages Conditional on Local Employment and Wages (Proposition 3)

Solving system (D.4) and deriving comparative statics with respect to R, holding L^{Sm} and W^m constant, yields

$$\frac{d\log k_j^*}{d\log R}|_{L^{Sm},W^m} = -\frac{(\eta-\sigma)bs_j + \sigma(b+\eta)}{\eta(1-s_j)+s_j\sigma+b} = -\frac{\eta bs_j + \sigma b(1-s_j)+\sigma\eta}{\eta(1-s_j)+s_j\sigma+b}$$

$$\frac{d\log l_j^*}{d\log R}|_{L^{Sm},W^m} = -\frac{(\eta-\sigma)bs_j}{\eta(1-s_j)+s_j\sigma+b}.$$

Since $\frac{d\log w_j}{d\log l_j} = \frac{1}{b}$ from the firm's labor supply curve, we get

$$\frac{d\log w_j^*}{d\log R}|_{L^{Sm},W^m} = \frac{d\log w_j^*}{d\log l_j^*}\frac{d\log l_j^*}{d\log R}|_{L^{Sm},W^m} = -\frac{(\eta-\sigma)s_j}{\eta(1-s_j)+s_j\sigma+b}.$$

These effects depend on the share of capital efficiency units as follows:

$$d\left(\frac{d\log w_j^*}{d\log R}|_{L^{Sm},W^m}\right)/ds_j = -\frac{(\eta-\sigma)(\eta+b)}{\left[\eta(1-s_j)+s_j\sigma+b\right]^2},$$

$$d\left(\frac{d\log l_j^*}{d\log R}|_{L^{Sm},W^m}\right)/ds_j = -\frac{(\eta-\sigma)b(\eta+b)}{\left[\eta(1-s_j)+s_j\sigma+b\right]^2},$$

$$d\left(\frac{d\log k_j^*}{d\log R}|_{L^{Sm},W^m}\right)/ds_j \;=-\frac{(\eta-\sigma)[b(\eta+b)+(b+\eta)\sigma]}{\left[\eta(1-s_j)+s_j\sigma+b\right]^2}.$$

Moreover, if $\eta > \sigma$ and $\sigma > 1$, which ensures that $\frac{ds_j}{d\theta_j} > 0$ (see Appendix D.1), we get

$$d\left(\frac{d\log w_j^*}{d\log R}|_{L^{Sm},W^m}\right)/d\theta_j \;= d\left(\frac{d\log w_j^*}{d\log R}|_{L^{Sm},W^m}\right)/ds_j \;\frac{ds_j}{d\theta_j} < 0.$$

$$d\left(\frac{d\log l_j^*}{d\log R}|_{L^{Sm},W^m}\right)/d\theta_j \;= d\left(\frac{d\log l_j^*}{d\log R}|_{L^{Sm},W^m}\right)/ds_j \;\frac{ds_j}{d\theta_j} < 0.$$

$$d\left(\frac{d\log k_j^*}{d\log R}|_{L^{Sm},W^m}\right)/d\theta_j \;= d\left(\frac{d\log k_j^*}{d\log R}|_{L^{Sm},W^m}\right)/ds_j \;\frac{ds_j}{d\theta_j} < 0.$$

We summarize these results in proposition 3:

Proposition 3:

a) $\frac{d\log k}{d\log R}|_{L^{mS},W^m} = -\frac{\eta b s_j+\sigma b\left(1-s_j^*\right)+\sigma\eta}{\eta\left(1-s_j\right)+s_j^*\sigma+b}$, where $s_j^* = \frac{k_j^{*\nu}}{(\theta_j l_j^*)^\nu+k_j^{*\nu}}$. Hence, $\frac{d\log k_j^*}{d\log R}|_{L^{mS},W^m} < 0$. Holding local wages and labor supply constant, an increase in the local business tax rate (and hence the cost of capital) will decrease the firm's capital stock.

b) $\frac{d\log l_j^*}{d\log R}|_{L^{mS},W^m} = -\frac{(\eta-\sigma)bs_j^*}{\eta\left(1-s_j^*\right)+s_j^*\sigma+b}$. Hence, $\frac{d\log l_j^*}{d\log R}|_{L^{mS},W^m} < 0$ if $\eta > \sigma$. Holding local wages and labor supply constant, increasing the local business tax rate will decrease firm employment.

c) $\frac{d\log w_j^*}{d\log R}|_{L^{Sm},W^m} = \frac{1}{b}\frac{d\log l_j^*}{d\log R}|_{L^{Sm},W^m} = -\frac{(\eta-\sigma)s_j^*}{\eta\left(1-s_j^*\right)+s_j^*\sigma+b}$. Hence, $\frac{d\log w_j^*}{d\log R}|_{L^{mS},W^m} < 0$ if $\eta > \sigma$. Holding local wages and labor supply constant, increasing the business tax will decrease firm wages.

d) If $\eta > \sigma > 1$, $d\left(\frac{d\log k_j^*}{d\log R}|_{L^{Sm},W^m}\right)\Big/ d\theta_j < 0$, $d\left(\frac{d\log l_j^*}{d\log R}|_{L^{Sm},W^m}\right)/d\theta_j < 0$, and $d\left(\frac{d\log w_j^*}{d\log R}|_{L^{Sm},W^m}\right)/d\theta_j < 0$. Hence (under this condition), holding local wages and labor supply constant, larger, higher-paying, and more capital-intensive firms reduce capital, employment, and wages more than smaller, lower-paying, and less capital-intensive firms.

D.6 Effects of Local Taxes $\boldsymbol{\tau^m}$ on Local Capital, Employment and Wages, once Firms adjust to Aggregate Wage and Employment changes

Recall from section D.2 that the labor supply curve to the firm is given by

$$\log l_j^* = \log L^{Sm} + b\log w_j^* \; - \log W^m. \qquad (D.5)$$

Aggregating individual firms' optimal wage and employment choices at local labor market level defines the aggregate wage level as $\log W^{*m} = \log \sum_{k\epsilon J^m} {w^*}_k^b$, and aggregate labor demand as $\log L^{*Sm} = \log \sum_{j\epsilon J^m} l_j^*$.

As equation D.5 shows, these aggregates shift individual firms' labor supply curves. Equilibrium therefore requires that individual firms' choices are optimal given aggregate choices in the local labor market. Moreover, local labor market equilibrium requires that, at the aggregate wage level optimally chosen by firms, labor supply to the local economy equals local labor demand:

$$\log L^{Sm}(W^{*m}) = \log \sum_{j\epsilon J^m} l_j^*.$$

Local labor supply is given by:

$$\log L^{Sm} = \log N^m + \frac{\log W^m}{\lambda} - \log\left(\exp\left(\frac{\log O}{\lambda}\right) + \exp\left(\frac{\log W^m}{\lambda}\right)\right).$$

The local labor supply elasticity therefore equals:

$$\frac{d\log L^{Sm}}{d\log W^{m}} = \frac{1}{\lambda}\frac{\exp\left(\frac{\log O}{\lambda}\right)}{\exp\left(\frac{\log O}{\lambda}\right) + \exp\left(\frac{\log W^{m}}{\lambda}\right)} \equiv \delta.$$

For simplification, we approximate labor supply to the local labor market by a log-linear labor supply curve with constant elasticity $\log L^{Sm} \approx \vartheta + \delta \log W^{m}$, implying an inverse local labor supply curve of:

$$\log W^{m} \approx \frac{1}{\delta}\log L^{Sm} - \frac{\vartheta}{\delta} \qquad (D.6)$$

In a first step, we substitute equation D.6 into D.5, which yields:

$$\log l_j^* = \frac{\vartheta}{\delta} + \log L^{Sm} - \frac{1}{\delta}\log L^{Sm} + b\log w_j^* = \frac{\vartheta}{\delta} + \frac{\delta - 1}{\delta}\log L^{Sm} + b\log w_j^*$$

To explicitly solve for the local labor market equilibrium, we assume there exists a representative firm j' such that aggregate employment is a multiple of that firm's employment according to $L^{Sm} = J^{m} l_{j'}$. This allows representing labor supply to the representative firm j in a way that internalizes the aggregate labor market reactions.

$$\log l_{j'}^* = \frac{\vartheta}{\delta} + \frac{\delta - 1}{\delta}\log \underbrace{L^{Sm}}_{J^m l_{j'}^*} + b\log w_{j'}^* = \frac{\vartheta}{\delta} + \frac{\delta - 1}{\delta}\log J^{m} + \frac{\delta - 1}{\delta}\log l_{j'}^* + b\log w_{j'}^*$$

$$\frac{1}{\delta}\log l_{j'}^* = \frac{\vartheta}{\delta} + \frac{\delta - 1}{\delta}\log J^{m} + b\log w_{j'}^*$$

$$\log l_{j'}^* = \tilde{\vartheta} + \delta b \log w_{j'}^* \qquad (D.7)$$

with $\tilde{\vartheta} = \vartheta + (\delta - 1)\log J^{m}$

Thus, if firms ignore the local labor market reaction (equation D.5), they optimize using a labor supply elasticity of b, while the representative firm that internalizes the local labor market reaction optimizes by considering the combined labor supply elasticity δb. The representative firm's employment, wage, and capital reactions, taking local labor market equilibrium into account, are thus:

$$\frac{d\log k_{j'}^{*}}{d\log R} = -\frac{(\eta-\sigma)\delta b s_{j'} + \sigma(\delta b+\eta)}{\eta\left(1-s_{j'}\right) + s_{j'}\sigma + \delta b} \qquad (D.8)$$

$$\frac{d\log l_{j'}^{*}}{d\log R} = -\frac{(\eta-\sigma)\delta b s_{j'}}{\eta\left(1-s_{j'}\right) + s_{j'}\sigma + \delta b}, \qquad (D.9)$$

$$\frac{d\log w_{j'}^{*}}{d\log R} = -\frac{(\eta-\sigma)s_{j'}}{\eta\left(1-s_{j'}\right) + s_{j'}\sigma + \delta b}, \qquad (D.10)$$

Comparing these effects to the individual firms' effects holding local wages and labor supply constant (parts a – c of Proposition 3) reveals that, if $\delta > 0$, the sign of the employment and wage effects remains the same when taking the local labor market adjustment into account. Thus, the local labor market adjustment simply reinforces or dampens the effects but does not change their signs. If η>σ, the same is true for the effect on capital.

From $L^{Sm} = J^m l_{j'}$ for the representative firm, and under the assumption that J^m is constant, we get the aggregate employment effect as

$$\frac{d\log L^{*Sm}}{d\log R} = \frac{d\log l_{j'}^{*}}{d\log R} = -\frac{(\eta-\sigma)\delta b s_{j'}}{\eta\left(1-s_{j'}\right) + s_{j'}\sigma + \delta b}.$$

If we additionally assume that wages of firm j' are representative for the local labor market $\left(\bar{W}^m = \sum_{k\epsilon J^m} w_k^* = J^m w_{j'}^*\right)$, then we get the aggregate wage effect (assuming J^m to be constant) as:

$$\frac{d\log \bar{W}^m}{d\log R} = \frac{d\log \sum_{k\epsilon J^m} w_k^*}{d\log R} = \frac{d\log J^m w_{j'}^*}{d\log R} = \frac{d\log w_{j'}^*}{d\log R} = -\frac{(\eta-\sigma)s_{j'}}{\eta\left(1-s_{j'}\right) + s_{j'}\sigma + \delta b}$$

D.7 Employment Effects of Business Taxation When Product and Labor Markets are Frictionless and Perfectly Competitive

Suppose that $\delta \rightarrow \infty$ (perfectly elastic labor supply to the local economy). In this case, wages equalize across local labor markets. Instead of deciding whether to offer their labor to a particular local labor market, workers now simply decide whether to participate in the labor market at all ($W^m = \overline{W}, L^{Sm} = \overline{L^S} \ \forall\, m$). Because municipalities are small compared to the national market, the aggregate wage level $\overline{W}$ and labor supply $\overline{L^S}$ are not affected by a local business tax increase and local labor market adjustment becomes irrelevant for firms' labor demand. Thus, the employment and capital reactions conditional on aggregate employment and wages derived in section D.3 are then also the unconditional employment and capital reactions: $\frac{d\log l_j^*}{d\log R} = \frac{d\log l_j^*}{d\log R}|_{L^{Sm},W^m} = -\frac{(\eta-\sigma)bs_j}{\eta(1-s_j)+s_j\sigma+b}$ and $\frac{d\log k_j^*}{d\log R} = \frac{d\log k_j^*}{d\log R}|_{L^{Sm},W^m} = -\frac{(\eta-\sigma)bs_j+\sigma(b+\eta)}{\eta(1-s_j)+s_j\sigma+b}$.

If in addition, labor supply to the individual firm is perfectly elastic (perfectly competitive labor market), firms' employment and capital adjustments simplify to:

$$\lim_{\delta,b\rightarrow\infty,} \frac{d\log l_j^*}{d\log R} = -(\eta-\sigma)s_j$$

and

$$\lim_{\delta,b\rightarrow\infty} \frac{d\log k_j^*}{d\log R} = -(\eta-\sigma)s_j + \sigma.$$

For a competitive product market, on the other hand, the effects reduce to:

$$\lim_{\delta,\eta\rightarrow\infty} \frac{d\log l_j^*}{d\log R} = -\frac{bs_j}{1-s_j}$$

and

$$\lim_{\delta,\eta\rightarrow\infty} \frac{d\log k_j^*}{d\log R} = -\frac{bs_j+\sigma}{1-s_j}.$$

For fully competitive labor and product markets, in turn, all economic activity disappears from the local economy in response to a tax increase:

$$\lim_{\delta,b,\eta\to\infty} \frac{d\log l_j^*}{d\log R} = -\infty$$

and

$$\lim_{\delta,b,\eta\to\infty} \frac{d\log k_j^*}{d\log R} = -\infty.$$

Hence, some forms of market imperfections are necessary for business tax rates to vary across local economies.

D.8 Deriving the Elasticity of Substitution Between Capital and Labor

The effects on capital, labor, and wages allow identifying the elasticity of substitution. Using equations D.8 - D.10, we find

$$\frac{\frac{d\log k_{j'}^*}{d\log R} - \frac{d\log l_{j'}^*}{d\log R}}{\frac{d\log w_{j'}^*}{d\log R} - \frac{d\log R}{d\log R}} = \frac{\frac{-\sigma(\delta b+\eta)}{\eta\left(1-s_{j'}\right)+s_{j'}\sigma+\delta b}}{\frac{-(\eta-\sigma)s_{j'}}{\eta\left(1-s_{j'}\right)+s_{j'}\sigma+\delta b}-1} = \sigma$$

Multiplying numerator and denominator by $\frac{d\log R}{d\log\,\tau^m}$, this yields

$$\sigma = \frac{\frac{d\log k_{j'}^*}{d\,\tau^m} - \frac{d\log l_{j'}^*}{d\,\tau^m}}{\frac{d\log w_{j'}^*}{d\,\tau^m} - \frac{d\log R}{d\,\tau^m}},$$

where $\frac{d\log k_{j'}^*}{d\,\tau^m}$, $\frac{d\log l_{j'}^*}{d\,\tau^m}$ and $\frac{d\log w_{j'}^*}{d\,\tau^m}$ correspond to the effects that we empirically estimate, and $\frac{d\log R}{d\,\tau^m}$ can be derived as follows:

Given $R = \frac{(1-\tau^m D)[r(1-\alpha\tau^m)+\delta]}{1-\tau^m}$, as defined in equation (3) of the main text, we note that

$$\frac{d\log R}{d\tau^m} = \frac{r[1-D-\alpha+D\alpha(2\tau^m-\tau^{m2})]+(1-D)\delta}{[r(1-D-\alpha+D\alpha(2\tau^m-\tau^{m2})+(1-D)\delta](1-\tau^m)^2}.$$

Given that $2\tau^m - \tau^{m2} > 0$ for any $0 < \tau^m < 1$, a sufficient condition for $\frac{dR}{d\tau^m} > 0$ is that $D + \alpha < 1$.

Evaluating $\frac{d \log R}{d\tau^m}$ at the parameters relevant in our context (α=.27, *D*=.60, τ^m=.135—see section **Error! Reference source not found.**) and at plausible values of the interest and depreciation rates (r=0.02, δ=0.098),[6] we get

$$\frac{d \log R}{d\tau^m} = \frac{\mathrm{r}[1 - \mathrm{D} - \alpha + \mathrm{D}\alpha\tau^{\mathrm{m}}(2 - \tau^{\mathrm{m}})] + (1 - \mathrm{D})\delta}{[\mathrm{r}(1 - \tau^{\mathrm{m}}\mathrm{D} - \alpha\tau^{\mathrm{m}} + \mathrm{D}\alpha\tau^{\mathrm{m}2}) + \ (1 - \tau^{\mathrm{m}}\mathrm{D})\delta]\ (1 - \tau^{\mathrm{m}})}$$

$$= \frac{0.02[(1-0.27-0.70+0.70x0.27x0.135(2-0.135)]+(1-0.70)*0.098}{[0.02(1-0.70x0.135-0.27x0.135+0.70x0.27x0.135^2)+(1-0.70*0.135)0.098](1-0.135)} = \frac{0.043}{0.093} = 0.457$$

Finally, using our establishment-level estimates of the effect on capital (Table 3, column 3) from the BvD sample, and the results on employment and wages for high-wage establishments (last column of Table 7, which corresponds best to the BvD sample that oversamples larger higher-paying firms), we get:

$$\sigma = \frac{\frac{d \log k^*_{j'}}{d\,\tau^m} - \frac{d \log l^*_{j'}}{d\,\tau^m}}{\frac{d \log w^*_{j'}}{d\,\tau^m} - \frac{d \log R}{d\,\tau^m}} = \frac{-2.41 + 1.38}{-0.76 - 0.457} = \frac{-1.03}{-1.217} = 0.85$$

[6] We obtain the real interest rate *r=0.02* as Germany's long-term nominal interest rate between 1999 and 2014 of 0.035 (https://data.oecd.org/interest/long-term-interest-rates.htm), and subtract Germany's average inflation rate of 0.015 over that period (https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG?end=2014&locations=DE&start=1999). To compute the depreciation rate, we obtain asset-specific depreciation rates for intangibles (0.211), industrial buildings (0.034), and tangible assets (0.155) from the EUKLEMS dataset (Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel, 2019). We compute the weighted average depreciation rate using the net capital stock variable of the EUKLEMS dataset (Capital stock net, volume 2010 ref.prices) for the market economy over the years 1999-2014. We create the same asset categories: tangible assets (the sum of TraEq+Omach+IT+CT), intangible assets (the sum of Soft_DB+RD+OIPP) and commercial buildings (Ocon). Weights are computed as the share of net capital created in these macro categories over the total for every year 1999-2014. We then take the average across years 1999-2014. The resulting weights are 0.1185 for intangible assets, 0.5314 for industrial buildings and 0.35 for tangible assets. We use the same weights to compute the average net present value of tax depreciation across assets categories, taken from "Tax Foundation, "Capital Cost Recovery across the OECD," https://github.com/PSLmodels/capital-cost-recovery/tree/master

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