How do Establishments Choose their Location? Taxes, Monopsony, and Productivity

Catherine van der List [*]

University of British Columbia [†]

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Abstract

To better understand the distribution of economic activity across space and the effects of place-based policies, I develop a model of the location choice of new establishments incorporating tax rates, monopsonistic labor markets, and spillovers. Results of the estimating equation with German establishment data indicate that establishments generally have a preference for lower taxes and worker outside options in their location choice, though some sectors do not. The degree to which various types of spillovers, or the benefits firms receive from other firms in a location, are an important influence on the location decision varies greatly between sectors. I quantify the effects of a theoretical place-based policy in each commuting zone in Germany. I find that commuting zones display highly heterogeneous responses to the same policy, with some areas experiencing predicted wage and economic activity growth and others declines.

1 Introduction

Economic activity is distributed unevenly across geographic space - with some areas enjoying low unemployment and high wages while others have high unemployment rates and low wages. The location decisions of firms reinforce this: a large number of establishments choose to go to high wage high productivity areas, while a much smaller number of firms choose underdeveloped areas. How this location decision is undertaken by establishments is largely unknown despite being of critical interest to governments, who develop place-based policies in an attempt to revitalize underdeveloped regions. It may also be the case that establishments value different location characteristics. Some establishments may prefer to leverage monopsony power to minimize their labor costs, while others could prefer being located near specialized labor or in hubs of technological innovation. Furthermore, these incentives likely compete with one another: highly productive locations with specialized labor and technological innovation are larger labor markets where firms will be less likely to be able to exert monopsony power.

In this paper, I present evidence on the extent to which monopsony power, spillovers, and taxes influence the location decision of establishments, and test the effects of policies (in the form of tax incentives) designed to attract establishments particular areas. Previous research has demonstrated that different levels of monopsony power and spillovers across space influences the geographic distribution of economic activity (Manning, 2009; Bamford, 2021; Ellison et al., 2010; Gaubert, 2018; Fajgelbaum and Gaubert, 2020), as well as the misallocation effects of heterogeneous corporate tax rates across space (Fajgelbaum et al., 2018). The relative importance of each of these factors may differ for establishments in different industrial sectors (Hanlon and Miscio, 2017; Faggio et al., 2020), and it is important to examine them simultaneously to accurately estimate their relative effects on establishment location choice (Jofre-Monseny and Solé-Ollé, 2010). To my knowledge, this is the first paper to examine all three of these factors in a unified framework of establishment location choice.

Starting from a model of imperfect competition in segmented labor markets, I show that there are four key inputs into the establishment location decision problem: corporate tax rates, market size, the degree of monopsony power, and the relative levels of productivity within each location. I also show that the conditional logit choice problem can be estimated tractably and easily using methods from the differentiated products models of the industrial organization literature and a model-derived estimating equation (Berry, 1994).

I implement this method using establishment-level data from Germany, combined with data proxying three Marshallian agglomerating forces[1], data on corporate-tax rates, and es-

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[1]Establishments may locate near one another to be closer to goods sellers and/or buyers, to pool labor,

timates of the degree of monopsony power in each commuting zone. My empirical findings point to the conclusion that establishments have heterogeneous preferences in the location characteristics they consider when they choose where to locate. In particular, three out of seven industrial sectors (mining utilities, and construction; manufacturing; and professional services) demonstrate a preference for locations where they are away from establishments using labor in similar occupations, while the other services sector locates close to such establishments. The remaining three sectors (agriculture, forestry, and fishing; trade and transportation; and education and health) do not take the similarity of local labor into account when choosing their location.

I also find strong heterogeneity in the valuation of reference wage levels in the establishment location choice. Five sectors (agriculture, forestry, and fishing; mining utilities, and construction; trade and transportation; professional services; and the other services sector, mostly comprised of personal services) prefer to locate in areas where reference wage levels are low, while the remaining sectors do not take reference wage levels into account in their decision process. In line with previous literature (Albouy, 2009; Suárez Serrato and Zidar, 2016), I find that establishments overall have a distaste for taxes, though two sectors are not sensitive to local tax rates in their location decision (trade and transportation; education and healthcare). I see little evidence of heterogeneous responses to taxes conditional on a statistically significant response.

In extensions, I find that congestion effects implied by the model coefficient estimates are confined to establishments with below-median productivity levels, but I find no such differences by establishment size. This suggests that more productive establishments are either able to better utilize positive spillovers, or they are less negatively affected by congestion effects.

Using the estimated coefficients from my empirical specification, I simulate the effects of a policy designed to attract establishments to particular locations. Specifically, I examine a policy where the federal government provides rebates for local corporate tax rates above the legally mandated minimum rate of 7%. Such a policy has both primary (tax-induced) and secondary (spillovers-from-new-establishments-induced) effects. Due to the model allowing these secondary effects, the model is not prescriptive about the sign or magnitude of the overall effect of the policy in terms of growth in establishments or wages. I find that in the counterfactual world, there is a great deal of heterogeneity in the overall response to the place-based policy.

In terms of the difference in the number of establishments compared to the actual policy, the estimated effects of leaving the place-based policy in place for 18 years ranges from -48%

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or to receive knowledge from other nearby establishments.

to 60%. In terms of the difference in wages, the effects range from -2.3% to 5.2%. I find that the degree of monopsony power in a commuting zone is a strong predictive factor in the percent change in establishments from the place-based policy, and a weakly predictive factor in the percent change in wages. Less competitive areas receive more benefit, in terms of establishment growth and wages, compared to more competitive areas.

This paper relates to a number of literatures in labor, urban, and public economics. First, a body of work has attempted to explain the spatial sorting of establishments (Behrens et al., 2014; Gaubert, 2018; Fajgelbaum et al., 2018; Bilal, 2021), which has traditionally focused on establishments entering perfectly-competitive labor markets. However, economists know from the recent literature on monopsony power (Ashenfelter et al., 2010; Falch, 2010, 2011; Schmieder, 2013; Azar et al., 2020; Schubert et al., 2021; Berger et al., 2022) that markets are not perfectly competitive in-practice. Two papers have examined the location choices of establishments in the context of imperfectly competitive labor markets (Manning, 2009; Bamford, 2021), but both of these papers assume homogeneous firms. Gaubert (2018) assumes perfectly competitive labor markets and heterogenous firms to examine the location choice of firms, but concentrates on whether more productive firms are better able to take advantage of a single generic type of spillover with no structure. In contrast, this paper concentrates on heterogenous valuation of different types of spillovers and how that contributes to differences in productivity of individual industrial sectors across geographic space.

Existing literature examining spillovers directly has concentrated on empirical measurement of the magnitude of spillovers or the three types of spillovers which may exist theoretically and how to distinguish between the them empirically (Moretti, 2004; Rosenthal and Strange, 2004; Glaeser and Gottlieb, 2009; Ellison et al., 2010; Hanlon and Miscio, 2017; Faggio et al., 2020). This paper confirms that establishments value spillovers in their location choice, and provides evidence that the heterogeneous valuation and utilization of spillovers has implications for the overall effects of place-based policies. In particular, spillovers explain why the same place-based policy may have different effects in different locations, as seen empirically in Greenstone et al. (2010) and Devereux et al. (2007).

The remainder of this paper is organized as follows. Section 2 outlines the model of establishment location choice, Section 3 describes the data, Section 4 discusses the results, Section 5 examines the effects of a theoretical place-based policy, and Section 6 concludes.

2 Model

I model firms' location choice is a partial-equilibrium monopsonistic model where establishments choose wages to maximize their profits subject to the workers labor supply equations.

As in Card et al. (2018), I use a static industrial-organization style differentiated products framework to describe how heterogeneous workers value jobs at different establishments. Within this framework, I model the location decision of a new establishment choosing which labor market to enter using a differentiated-products framework, where "products" are locations with different characteristics. Establishments solve their problem by backwards induction. First, the determine their optimal wage subject to the labor supply equation from the workers' utility maximization problem. New establishments choose which location to enter based on which market offers the establishment the highest level of profit.

2.1 Allocation of Workers to Establishments Within Labor Markets

In a particular labor market c and time t, each establishment indexed by j in industrial sector m posts a wage offer w_{cjt} which is fully and costlessly observed by all workers living in that market. Establishments are willing to hire any worker who will accept the job at the posted wage.

Workers have heterogeneous preferences over establishments, the utility function of worker i at firm j is given by:

$$u_{icjt} = \mu_c \ln(w_{cjt} - b_{ct}) + a_m + v_{icjt} \tag{1}$$

where b_{ct} is the outside option of workers living in location c, a_m are sector-specific amenities valued equally by all workers, and v_{icjt} is an idiosyncratic preference shock of workers for working at establishment j drawn independently from a type I extreme value distribution. Such preference shocks could be, for example, interactions with co-workers. Workers supply inelastic labor hours normalized to one. By the standard arguments of the McFadden choice model (McFadden, 1973) this leads to the logit choice equation of workers.

$$p_{icjt} = P(\underset{k \epsilon 1,...,J}{argmax} = j) = \frac{\exp(\mu_c ln(w_{cjt} - b_{ct}) + a_m)}{\sum_{k=1}^{J} \exp(\mu_c ln(w_{ckt} - b_{ct}) + a_m)} \tag{2}$$

Assuming the number of establishments is sufficiently large in each location that firms are not strategically interacting in their wage setting, this logit-choice equation may be approximated by the exponential probability.

$$p_{icjt} \approx \lambda_{ct} \exp(\mu_c ln(w_{cjt} - b_{ct}) + a_m) \tag{3}$$

where λ_{ct} is constant for all establishments in market c. Since aa establishment's number of employees is the available pool of workers in the location times the probability a worker

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chooses the establishment, the labor supply equation of the establishment directly follows.

$$L_{cjt}(w_{cjt}) = \mathcal{L}_{ct}\lambda_{ct}\exp(\mu_c ln(w_{cjt} - b_{ct}) + a_m) \tag{4}$$

where $\mathcal{L}_{ct}$ is the size of the labor force in market c.

2.2   Optimal Establishment Behavior Within a Market

Individual establishments maximize their profits conditional on the market they operate within by posting an optimal wage subject to the labor supply behavior of workers outlined above. An individual establishment's profit equation for market c is given by:

$$Y_{jc} = (1 - \tau_{ct})(\beta_{ctm}L_{cjt}(w_{cjt}) - L_{cjt}(w_{cjt})w_{cjt}) \tag{5}$$

Establishments have a marginal product of labor β_{ctm} which differs by industrial sector and location. I remain agnostic about the exact form of this productivity, but it may be thought of as a function of agglomeration, spillovers, natural advantage, and worker characteristics available to the establishment in a given location. These benefits are allowed to differ by industrial sector since it is plausible that different types of establishments value different types of agglomeration and spillovers differently (i.e. tech companies likely value intellectual knowledge spillovers more highly than retail trade establishments). Corporate taxes for each market are denoted by τ_{ct}.

Establishments cannot observe workers' idiosyncratic preference shocks v_{icjt}, so they post a single optimal wage by maximizing their profit equation subject to the labor supply equation (4). Using the first order condition of the profit equation and the labor supply equation, the optimal wage posted by the establishment is:

$$w_{cjt} = \frac{\mu_c}{1 + \mu_c}\beta_{ctm} + \frac{1}{1 + \mu_c}b_{ct} \tag{6}$$

This wage equation takes the form of a weighted average of the marginal product of labor and the outside option available to workers in the establishments' location. The form of the equation demonstrates the manner in which monopsony power is exerted by firms, as $\mu_c \to \infty$ markets become perfectly competitive. Furthermore, as worker outside options increase, wage levels must also increase, with the relative importance of productivity and outside option in wage setting determined by the elasticity of labor supply to the establishment μ_c. Of note, since productivity β_{ctm} varies at the sector and commuting-zone level and b_{ct} varies at the commuting-zone level, wages are sector and commuting-zone specific rather than establishment specific.

Substituting labor supply and wage equations and log-linearizing leads to the log-profit equation.

$$y_{ctj} = ln(1 - \tau_{ct}) + ln(\mathcal{L}_{ct}\lambda_{ct}) + (1 + \mu_c) \ln \left[\frac{1}{1 + \mu_c}(\beta_{ctm} - b_{ct}) \right] + a_m + \mu_c ln(\mu_c) + u_{ctj} \quad (7)$$

Where u_{ctj} is an idiosyncratic log-profit shock with a type I extreme value distribution.

This log-profit equation has several key components. The first is taxes $ln(1 - \tau_{ct})$, the second is a market size term $ln(\mathcal{L}_{ct}\lambda_{ct})$, and the third is the relative productivity of workers compared to the outside option $(1 + \mu_c) \ln \left[\frac{1}{1+\mu_c}(\beta_{ctm} - b_{ct}) \right]$.

2.3 Modeling Location Choice

Within this framework, I model the location choice of new establishments entering the labor market[2]. Establishments solve their location choice problem by first solving for the optimal wage they would pay in each individual market, then choosing the location where log profit is highest. Since the idiosyncratic shocks to profit in equation (7) are drawn from a type I extreme value distribution, establishments have the standard logit probability of locating in location c. Since establishments in the same industrial sector have the same preferences over locations, this logit probability approximates the share of establishments of a particular industrial sector which locate in location c.

$$s_{ctm} \approx p_{ctm}$$
$$= \frac{exp\left[ln(1 - \tau_{ct}) + ln(\mathcal{L}_{ct}\lambda_{ct}) + (1 + \mu_c)ln[\frac{1}{1+\mu_c}(\beta_{ctm} - b_{ct})] + a_m + \mu_c ln(\mu_c) \right]}{\sum_{k=1}^{C} exp\left[ln(1 - \tau_{kt}) + ln(\mathcal{L}_{kt}\lambda_{kt}) + (1 + \mu_k)ln[\frac{1}{1+\mu_k}(\beta_{ktm} - b_{kt})] + a_m + \mu_k ln(\mu_k) \right]} \quad (8)$$

Dividing this share equation by the share of establishments choosing a base location s_{0tm} and taking logs leads to the structural share-ratio equation (Berry, 1994).

$$ln(\frac{s_{ctm}}{s_{0tm}}) = ln(1 - \tau_{ct}) + ln(\mathcal{L}_{ct}\lambda_{ct}) + (1 + \mu_c)ln \left[\frac{1}{1 + \mu_c}(\beta_{ctm} - b_{ct}) \right] + \mu_c ln(\mu_c)$$
$$- ln(1 - \tau_{0t}) - ln(\mathcal{L}_{0t}\lambda_{0t}) - (1 + \mu_0)ln \left[\frac{1}{1 + \mu_0}(\beta_{0tm} - b_{0t}) \right] - \mu_0 ln(\mu_0) \quad (9)$$

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[2]I concentrate on new establishments because it's extremely rare for establishments to change location (in my data, 1.60% of establishments do so in their lifetime), while new establishments are by definition choosing a location.

The log share of establishments of sector m choosing location c in time t compared to a benchmark location 0 is a function of the taxes in both locations, the market sizes of both locations, and two terms comprising market power and the relative productivity of labor compared to their outside option.

Guimarães et al. (2003) demonstrates the equivalence of estimation of the conditional logit Equation (8) and a poisson regression under certain circumstances. Appendix A explains this method in more detail and its assumptions. I also show that the distributional assumptions necessary for the equivalence of poisson and conditional logit are not met. As the share-ratio regression does not require these additional assumptions, it it more appropriate for this analysis.

2.4   Estimating Equation

I run the following two-way-fixed-effects specification separately for each industrial sector:

$$
\begin{aligned}
ln(\frac{s_{ctm}}{s_{0tm}}) - \mu_c ln(\mu_c) =& \beta_0 + \beta_1 ln(1 - \tau_{ct}) + \beta_2 ln(\mathcal{L}_{ct}\lambda_{ct}) + \beta_3 Spillovers_{ctm} + \beta_4 b_{ct} \\
& + \beta_5 X_{ctm} + \gamma_c + \zeta_t + u_{ctm}
\end{aligned}
\tag{10}
$$

The latter four terms of equation (9), the base-location utilities, are cleanly captured by the time-fixed effect ζ_t. In order to control for the market-size term $ln(\mathcal{L}_{ct}\lambda_{ct})$ directly, I pre-estimate it in a first step, which I outline in Appendix C. I also estimate μ_c separately using the method of Bassier et al. (2022), also described in Appendix C.

Given data on corporate tax rates, τ_{ct}, the only remaining term of the structural equation is $(1+\mu_c)ln\left[\frac{1}{1+\mu_c}(\beta_{ctm} - b_{ct})\right]$. This term incorporates two forces which vary across locations and time within sector: the productivity of an establishment in sector m and the outside option available to workers. For the empirical specification, I construct an empirical proxy for outside option b_{ct} which will be explained in detail in Section 3. I also construct empirical proxies for three types of agglomerating forces, which will also be discussed in detail in Section 3.

I additionally control for commuting zone characteristics which may be correlated with productivity, such as share of highly educated workers in the commuting zone[3]. Natural advantage is captured by the location fixed effect γ_c. After estimation, I back out estimated values for the sector-location level productivity using the structural equation.

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[3]Specifically, all empirical specifications include controls for share highly/medium qualified workers, share women, share full-time workers, share prime aged workers, and share German workers.

3 Data and Summary Statistics

In this section, I outline the various data sources I use to estimate my model. In this section, I first describe my main source of data on individual firms, then the empirical proxies I use for three types of spillovers, and finally additional necessary data. Once all of these sources of data are combined, I have a panel spanning the years 1999 to 2017.

3.1 Establishment Data

The core source of data for this project is the Establishment History Panel (BHP) of the Institute for Employment Research (IAB) of the Federal Employment Agency (BA) of Germany. The data are a random 50% sample of all establishments[4] in West Germany from 1975 onward and East Germany from 1992 onward on an annual basis. Appendix B describes adjustments to the structural equations and bounding exercises to account for the fact that I cannot link establishments to parent firms. The data covers all establishments with at least one employee eligible for social security. The data consists of information about the establishments themselves such as industry as well as information about employee characteristics such as number of highly-qualified workers at the firm and median daily wages. Critically, the data also includes information on establishment location. My preferred location definition is the commuting zone, of which there are 141 in Germany.

Table 1 shows summary statistics concerning the size of establishments and industrial sector of establishments over the sample period. The majority of establishments have fewer than five employees over the entire period, though the average size is growing larger over time. The number of overall entrants has also declined over time, accounting for some of the change in composition. There are fewer small businesses being started, but more similar number of very large establishments. The largest industrial sectors are, broadly defined, the trade and service sectors (other comprises mostly personal services).

There are a number of other data sources merged to the BHP for analysis. An overview of the variables and their sources is shown in Table 2. I will discuss the construction of key variables in detail below.

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[4]Establishments cannot be linked across locations to a parent firm, but all establishments of the same firm in one location are combined. For example, all of the McDonald's in Berlin are combined into one line in the data, but I cannot link McDonald's in Berlin and McDonald's in Munich as being associated with the same firm.

3.2 Proxies for Agglomerating Forces

I incorporate empirical measures of the Marshallian agglomerative forces in my analysis. In constructing these empirical proxies, I follow Ellison et al. (2010) (hereafter EGK). EGK develop empirical proxies for the strength of these three forces between two industries. Establishments may locate close to one another to reduce the costs of sourcing inputs from suppliers or the costs of shipping outputs to customers. This efficient moving of goods is proxied by the strength of input-output relationships between a pair of industries. Establishments may also locate close to one another if they use similar types of labor to ensure that workers the workers they need to hire are located nearby. Efficient moving of labor is proxied by a vector correlation of occupational shares between two industries. Establishments may also locate near one another to share ideas and innovations. Efficient moving of ideas is proxied by the strength of patent citation relationships between two industries.

The key difference between my own measure and those in EGK is that their paper develops a set of pairwise-industry-level measures of agglomeration which is used to assess how important each factor is to the coagglomeration of various industries. However, I require a location-level measure of agglomerative forces as my analysis concerns locations rather than pairwise industries. To convert pairwise-sector-level measures of coagglomeration to an sector- and location-level measure I use a weighted average of the pairwise-sector measures weighted by industrial sector establishment shares in a particular location. As a simple example, imagine there are two sectors 1 and 2. Sector 1 has a pairwise-level agglomeration relationship of .75 with sector 1, and .25 with sector 2. Then, for a establishment in sector 1 in a location with an equal share of establishments from sector 1 and 2 their establishment-level agglomeration is .5*.75 + .5*.25 = .5. Below I describe the construction of these proxies formally.

3.3 Goods Agglomeration

To proxy efficient moving of goods, I first construct a measure of the strength of input-output linkages between sectors. $Input_{m \leftarrow m'}$ is the share of sector m's inputs which come from sector m', and $Output_{m \rightarrow m'}$ is the share of sector m's output which goes to sector m'. For an establishment in sector m, their input-output relationship with sector m' is defined as the maximum of these two values. Then the weighted average is calculated as described above to obtain the input-output agglomeration benefits for locating in each possible location. For an establishment in sector m in location c and time t their input-output agglomeration benefits are therefore:

$$\text{IO Agglom}_{ctm} = \sum_{m'=1}^{M} \frac{N_{ctm'}}{\mathcal{N}_{ct}} max(Input_{m \leftarrow m't}, Output_{m \rightarrow m'}) \tag{11}$$

Thus, the measure of input-output agglomeration benefits is measured for a particular sector, location and year cell. Figure 1 shows the strength of input-output linkages by industrial sector and commuting zone for the year 1999. The figure shows that the strength of input-output linkages varies across space, with different areas providing stronger potential input-output linkages for different sectors.

3.4   Labor Agglomeration

To proxy efficient pooling of labor, I first construct a measure of the similarity of labor used by a sector pair. For each sector, I construct a vector of the shares of industrial employment of each three-digit occupation. Then, for sector m and m' the vector correlation is the labor correlation of industry pair, $LC_{m,m'}$. Then the weighted average is calculated to obtain the labor correlation agglomeration benefits for locating in each possible location. For a firm in sector m in location c and time t their labor correlation agglomeration benefits are therefore:

$$\text{LC Agglom}_{ctm} = \sum_{m'=1}^{M} \frac{N_{m'ct}}{\mathcal{N}_{ct}} LC_{m,m't} \tag{12}$$

As with input-output agglomeration above, this measure of agglomeration benefits varies by sector, location and year. Figure 2 shows the strength of labor linkages by industrial sector and commuting zone for the year 1999. The figure shows that the strength of labor linkages varies across space, with different areas providing stronger potential labor linkages for different sectors.

3.5   Knowledge Agglomeration

My measure of knowledge spillovers in a location comes from Jaffe et al. (1993). For each patent, I define a control patent as the patent with the closest publication date in the same 3-digit IPC patent class as the main patent. For each patent I also identify the commuting zone where the patent originates, as well as the region where each cited patent introduced by the applicant originates, both excluding and including self-citations. Then, for each location I define the knowledge agglomeration as the probability a cited patent comes from the same region (pr_{cite}) minus the probability that the control patent comes from the same region (pr_{cntrl}). This proxy measures knowledge spillovers since it measures the percentage

of citations in a patent that are from the same location over-and-above the level that you would expect from the distribution of patents.

3.6 Construction of Additional Variables for Analysis

In addition to agglomeration, taxes also play a role in establishment location choice (Fajgelbaum et al., 2018). Corporate tax rates in Germany are set at a base level by the federal government, but individual municipalities are permitted to set their own corporate tax rates in the form of a multiplier on the federal rate of 3.5%. Changes in these rates are frequent, and are largely exogenous to local economic conditions (Fuest et al., 2018). I have obtained data on these municipal tax rates and aggregated them to the average commuting zone level using a weighted-average with municipal population as the weight.

Figure 3 shows the average corporate tax rates for the years 2000, 2010, and 2017. Tax rates are generally increasing throughout the time period of my panel, and are highest in northwestern Germany, while the lowest in the south and parts of the east.

I also construct an empirical proxy for the outside option of workers within a commuting zone. I follow the approach of Card et al. (2013) and construct the average outside option as an employment-share weighted average of sectoral union minimum wage rates. I approximate the union minimum wage rate with the 20th percentile of the establishment-level distribution of low-qualification employees' mean wages.

Union minimum wages rates are not straightforward to obtain for Germany, so I have developed a data-based method to approximate the union minimum wage rate. There is no central repository of union contracts available for Germany, but I obtained the 2019 union contracts for the state of North-Rhine Westfalia. In the contracts, the minimum wage rate and the effective date is specified, typically as a monthly rate. There are different rates for different skill levels, I concentrate on the low-skill level for my analysis. Union contracts oftentimes do not map cleanly into a single industry code in the BHP data. I chose four two-digit industry codes (retail trade, wholesale trade, chemical industry, and transportation/logistics) which map into a single union contract, and have large enough employment in 2019 in North-Rhine Westfalia to analyze wage distributions. I have union contracts for 2019, but my main analysis data is only available through 2017. To approximate the union rates in 2017, I average the minimum wage growth rates for 2020 and 2021 to approximate the average wage increases year-over-year. On average, the minimum wage grows around 100 Euros per year, so I use this to back out an estimated 2017 minimum wage.

The BHP data has information about the wages of low-qualification workers (high school

or less, no vocational qualification) at the establishment. For establishments with twenty or more employees, I plot the wage distribution of these low-qualification employees in Figure 4 along with the estimated minimum wage rates described above. As can be seen in Figure 4, with the exception of wholesale trade the union minimum wage rate falls at approximately the 20th percentile of the low-qualification wage distribution. Thus, I proxy the union minimum wage rate as the 20th percentile of the low-qualification wage distribution in a particular two-digit industry-state-year cell. These union minimum wage rates are aggregated to the location-level using establishment-sector-share weights as with the agglomerating forces described above. Figure 5 shows the geographic distribution of the outside option proxy aross space. There is a clear delineation between former East- and West-Germany, with former East Germany having persistently lower outside option compared to former West Germany.

4 Empirical Strategy and Results

4.1 Empirical Strategy

Revisiting the estimating equation:

$$
\begin{aligned}
ln(\frac{s_{ctm}}{s_{0tm}}) - \mu_c ln(\mu_c) =& \beta_0 + \beta_1 ln(1 - \tau_{ct}) + \beta_2 ln(\mathcal{L}_{ct}\lambda_{ct}) + \beta_3 Spillovers_{ctm} + \beta_4 b_{ct} \\
& + \beta_5 X_{ctm} + \gamma_c + \zeta_t + u_{ctm}
\end{aligned}
\tag{10}
$$

There may be bias in the estimates of β_3 and β_4. Specifically, there may be unobserved demand or productivity shocks which impact the distribution of incumbent establishments in the commuting zones used as weights in the spillover proxies and outside option measure. These unobserved demand or productivity shocks may also make the location more attractive to new establishments, affecting the share-ratio.

In order to correct for this, I construct a shift-share instrument. Specifically, I instrument the weights in the spillover proxy and outside option weighted averages with:

$$
\hat{N}_{mct} = N_{mc,1998} * growth_{mt,-c}
\tag{13}
$$

where $N_{mc,1998}$ is the number of incumbent establishments in sector m and commuting zone c in the pre-period 1998, and $growth_{mt,-c}$ is the leave-out growth rate in sector m in similarly sized[5] commuting zones between 1998 and t.

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[5]Specifically, I split the 141 commuting zones into quartiles (35 commuting zones each) and construct the growth rates as the leave-out growth rates within these quartiles.

4.2 Results

Figure 6 shows the results of the main specification. Each panel shows point estimates of a coefficient of interest as well as 95% confidence intervals. Appendix figure $F.1$ shows the corresponding OLS results. Table 3 shows the exact point estimates and F statistics for each specification. For all specifications, taxes, input-output spillovers, and the outside option are log-transformations and the labor correlation spillovers measure is an inverse hypersine transformation. To account for serial correlation of the error term within a given commuting zone, the standard errors in all regressions are clustered at the commuting zone level.

Establishments in most economic sectors have a distaste for taxes[6], though there is strong evidence of heterogeneity in the importance of taxes. Five sectors (agriculture, forestry, and fishing; mining utilities, and construction; manufacturing; professional services; and the other services sector, mostly comprised of personal services) display a significant aversion to taxes in their location choice. Neither the trade and transportation sector or the education and healthcare sector demonstrate sensitivity to local tax rates. Conditional on responding to taxes, there is only weak evidence that sectors display heterogeneous sensitivity. Though the point estimates range from 8.86 in the professional services sector to 12.62 in the manufacturing sector, the confidence intervals of the estimates are strongly overlapping.

The results also indicate that establishments in all economic sectors either prefer lower outside-options or are indifferent. As discussed in Section 2, higher outside options force establishments to pay higher wages. Thus, a negative coefficient on outside option may be thought of as demonstrating a preference on the part of their ability to markdown wages they would pay to their workforce. As in the case of taxes, five sectors display a preference for lower outside options in their choice of location (agriculture, forestry, and fishing; mining utilities, and construction; trade and transportation; professional services; and the other services sector, mostly comprised of personal services), while the manufacturing sector and the education and health sector do not. With respect to outside option, there is stronger evidence of heterogeneous responses by industrial sector. The strongest response, from the professional services sector with a coefficient of -4, and the weakest statistically significant response, from the mining utilities and construction sector of -2.1, are statistically distinguishable from one another and the magnitude of the point estimate for professional services is nearly twice as large.

Utilization of spillovers differs substantially by economic sector, particularly the valuation by establishments of locating near establishments that use similar types of labor. Three sectors (mining utilities, and construction; manufacturing; and professional services) prefer to

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[6]Estimated coefficients are positive because the independent variable is $ln(1 - \tau_c)$

be located away from establishments which use workers in similar occupations to themselves, with the magnitude of the effect ranging from -61.67 in the manufacturing sector to -27.58 in the professional services sector. This is suggestive that for these industrial sectors, there are congestion effects to being located too close to one another. There is weak evidence that the other services sector prefers to be located near establishments using workers in similar occupations, though it is only significant at the 10% level. Three sectors (agriculture, forestry, and fishing; trade and transportation; and education and health) are unresponsive to the presence of establishments with similar occupational profiles.

Preferences for locating close to firms which are more likely to provide goods inputs or buy outputs are less important. The only sector which displays a preference for locating near to or away from establishments providing inputs or buying outputs is the other services sector. This sector prefers to locate away from establishments they buy from or sell to, which suggests that this sector may find a shortage of inputs or customers if there are too many other service providers nearby.

Though preferences surrounding nearby goods linkages are largely irrelevant in the main specifications, this may be because my definition of economic sector is overly broad to capture dynamics surrounding the use these types of inputs. For example, though manufacturing is a single sector inputs used in auto manufacturing may be very different from those used in pharmaceutical manufacturing. Table 4 shows the results of the main IV regression for a more disaggregated definition of industrial sector. These results are suggestive that this may be the case, with much more heterogeneity in the sign and size of the coefficient on both main spillover measures in comparison to the main results in Table 3. However, the results for the finer industry disaggregation have smaller sample sizes and the instrument is weaker. Furthermore, the underlying data is more sparse[7], so results should be taken as suggestive.

Knowledge spillovers are only statistically significant in the case of the manufacturing sector. It is possible that this is because the measure of knowledge is not relevant for non-manufacturing firms. I cannot match patent technology to a sector in the BHP data, so the measure if only at the commuting-zone level. The measure is also relatively sparse, with roughly 15% of patents being filed in Munich each year, and more than 40% of those patents being filed by Siemens, a manufacturing conglomerate. This is suggestive that the coefficient is significant only for the manufacturing sector because the measure is the most relevant for this sector.

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[7]I.E. there is a larger proportion of commuting zones with only one establishment in the sector-year pair picking it, so results are less stable.

4.3 Tradability

One might expect that there would be differences in how establishments producing tradable goods value a location's characteristics. Table 5 shows the share of establishments in the data which are classified as tradable using the definition of Dauth et al. (2017), based on the two-digit-industry-level import penetration and export opportunities using UN Comtrade data.

As the table shows, for the purposes of analysis, two sectors may be thought of as tradable (agriculture, forestry and fishing; manufacturing). Both of these sectors have all establishments in the underlying data in industries classified as medium or high tradability in the data. Three sectors may be though of as non- or low-tradable (mining, utilities, and construction; trade and transportation; and the education and health sector), with more than 90% of establishments producing non- or low-tradability goods. Two sectors (professional services and other services) are mostly non- or low-tradability with a sizable minority (roughly 20%) of establishments within-sector producing medium-tradability goods.

Comparing the relationship between the tradability index and estimated regression coefficients, there is no clear pattern. This suggests that individual sectoral needs are more important than a broad definition of tradability in the location-choice problem.

4.4 Heterogeneity by AKM Firm-Effect and Establishment Size

I perform several extensions of my main results. The first is splitting the sample by above-median and below-median Abowd et al. (1999) (hereafter AKM) effect. Although AKM effects are not a direct measure of firm productivity, the AKM firm-effect is correlated with worker value-added (Card et al., 2015). Previous research (Gaubert, 2018) has demonstrated that more productive firms are able to better utilize the benefits of agglomeration economies. This leads to sorting of more productive firms to larger cities. In order to test whether firms with different levels of productivity consider different characteristics of locations when making their location decision, I repeat the specification in equation 10 separately for above- and below-median AKM effect establishments.

Figure 7 and Table 6 shows the results. Panel A shows the estimated coefficients and 95% confidence intervals for each industrial sector. The coefficients on the tax rates are largely overlapping for both below- and above-median AKM effect establishments, though the coefficient is significant in more sectors (3) for below-median-effect establishments compared to above-median-effect establishments (2). Overall, there does not seem to be evidence that productivity leads to more or less sensitivity to tax rates in the location decision.

There do seem to be differences in how the outside option is valued between higher and

lower productivity establishments as shown in panel B, with below-median AKM establishments being more likely to place value on the outside option in their decision making process, and the estimated magnitudes of the effect being much larger. For below-median AKM establishments, the sector with the smallest magnitude statistically significant response has an estimated coefficient of -3.6, while for above-median AKM establishments the largest magnitude statistically significant response is -1.8. This result makes sense, since less-productive establishments will, by definition, have a productivity closer to the outside option[8]. So, in order to make more profits lower outside options benefit them more than higher productivity establishments.

In the case of spillovers, it seems that negative coefficients for labor correlation seen in 6 Panel D are being driven almost entirely by below-median AKM effect establishments. Only the mining, utilities, and construction sector has a significant response to labor spillovers for above-median AKM effect establishments. This suggests that congestion effects within a market either primarily effect low-productivity establishments, or that if there are congestion effects for high-productivity establishments they are counterbalanced by positive spillovers. Determining which is the case is beyond the scope of this paper, but if it is the case that high-productivity establishments are receiving spillovers which compensate for congestion effects this result would be consistent with the findings of (Gaubert, 2018).

I also split the sample by establishment size to see if there are meaningful differences in behavior between larger and smaller employers, with results shown in Figure 8 and Table 7. These results are much more consistent between large and small establishments compared to the previous results for productivity. The point estimates for the coefficients are within overlapping confidence intervals for all sectors and inputs, suggesting that smaller and largeer establishments do not behave indistinguishably differently from one another. Though, as a caveat, recall from Table 1 that the median establishment is less than five employees, it's possible that very large establishments do behave differently and my sample size is not large enough to detect it.

Taken together, these two results suggest that policies increasing wages in low-wage regions may make the location less attractive to less productive establishments. Analyzing net welfare effects of such a change is beyond the scope of this paper, but would likely depend on whether phasing out such establishments would lead to workers having jobs at higher wages, or if unemployment would increase. It also suggests that tax incentives to attract establishments utilizing a particular type of labor, if they are initially successful in their endeavor, may ultimately attract more productive establishments which aren't as

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[8]Recalling one of the terms of the log-profit equation, $(1 + \mu_c)ln[\frac{1}{1+\mu_c}(\beta_{ctm} - b_{ct})]$, β_{ctm} will be lower for the below-median AKM effect establishments

sensitive to congestion effects as low-productivity establishments.

4.5 Rental Prices

Rental prices are another important factor which may influence establishment location choice (Glaeser and Gottlieb, 2009). In Appendix D I show changes which would be made to the model equations to account for rental prices, as well as the results of an empirical regression controlling for rental prices. Controlling for rents does not change the point estimates of the coefficients of interest, and though three sectors (mining, utilities, and construction; trade and transportation; education and health) respond to rental prices in their location choice, the significance is marginal at the 10% level for all three.

4.6 Model Fit

I test how well the model fits the data by calculating the estimated commuting-zone-sector-year wage using Equation 6 and the backed out productivity estimates from the structural Equation 9, and regressing the actual commuting-zone-sector-year wage on the imputed wage. The results are shown in Table 8. The coefficient on imputed wage is 1.43, and the intercept is -8.89 euros/day.

5 Counterfactual Firm and Wage Distributions

In this section I simulate a place-based policy designed to attract establishments to a commuting zone. I simulate a policy where the federal government provides a rebate for local corporate taxes for establishments locating in a particular commuting zones, effectively setting the local tax rates to 7% (the lowest legally permitted rate) in treated areas. I first show that my model produces heterogeneous responses to an identical place-based policy in different locations within Germany. I then undertake a case study on the effects of undertaking the policy in four commuting zones to illuminate the importance of sectoral dynamics in explaining the heterogeneous effects.

5.1 Effects of Tax Policy - Theory

Intuitively, a change in tax policy, or any place-based policy more generally, will have both immediate and secondary effects. Immediately, the tax policy will attract new establishments, some of which would not have otherwise gone to the treated location. Subsequently,

the composition of establishments in the area has changed and spillovers available to establishments by going to the area have also changed. Figure 9 shows a simplified version of this process.

The figure illustrates the effects of a tax change implemented in time t=0. Between time 0 and 1, the taxes have decreased, so the overall share ratio increases as shown in the leftmost graph. Now, in subsequent years the new entrants have moved the input-output spillovers, shown in the second graph. In this example, the input-output spillovers have decreased, and the dashed line shows an alternative possible path. As is clear in the figure, the overall movement in the share-ratio as a result of the tax policy is unclear over multiple years. It is possible for negative spillovers to be induced by the tax change and actually make the location overall less attractive to new establishments.

More formally, the movement in the share ratio due to the tax rate between t=0 and 1 is:

$$ln(\frac{s_{jct}}{s_{j0t}})_{CF} - ln(\frac{s_{jct}}{s_{j0t}})_{actual} = \beta_1[ln(1 - \tau_{CF,t}) - ln(1 - \tau_{ct})] \tag{14}$$

Where $\tau_{CF,t}$ is the counterfactual tax rate of 7%. Subsequently, the number of counterfactual entrants attracted by the tax policy may be calculated directly. Since the sum of shares for each location-year must sum to one in both the actual and counterfactual world, and rearranging implies that:

$$s_{j0t,CF} = \frac{1}{\sum_{ct} \frac{s_{1t,CF}}{s_{j0t,CF}} + ... + \frac{s_{Ct,CF}}{s_{j0t,CF}}} \tag{15}$$

Combining equations 14 and 15 leads directly to the expression for the counterfactual share of establishments choosing the treated location. I impose the additional assumption that the pool of establishments entering the entire German market each year is fixed in order to be able to calculate the counterfactual numbers of establishments going to each location. In Appendix E I relax this assumption and provide bounds for my main results.

I use this new distribution in firms to calculate the counterfactual spillovers establishments receive in the treated locations, which translates to the counterfactual productivity of firms using the structural equation.

$$(1 + \mu_c)ln[\frac{\beta_{ctm,CF} - b_{ct,CF}}{\beta_{ctm} - b_{ct}}] = \beta_3(Spillovers_{ctm,CF} - Spillovers_{ctm}) + \beta_4(b_{ct,CF} - b_{ct}) \tag{16}$$

Using this counterfactual productivity and outside option I additionally calculate counterfactual wages using model Equation 6. I continue this process iteratively to examine the

dynamic secondary effects induced by the tax policy change.

5.2 Counterfactual Results for All Commuting Zones

Figure 10 shows the estimated effects of tax policy if implemented in each individual commuting zone beginning in 1999, both after 9 years in 2008 and 18 years in 2017. Panel A shows the percent difference in establishments under the counterfactual tax policy compared to the actual tax policy, and panel B the percent difference in wages. The figure shows that the effects of a place-based policy are extremely heterogeneous, with some locations experiencing large increases in the number of establishments, while others actually experience declines in the number of establishments. For wages, the majority (more than 90%) of locations experience increases, but the magnitude of the increase is larger in some locations than others, with the maximum being roughly 5%. Furthermore, it seems counterproductive to keep the tax policy in place for a long period of time in the majority of cases, with the exception of a few winning commuting zones, outcomes are actually worse after 18 years of tax policy compared to 9 years.

It may be of interest to policymakers to predict the effects of a place-based policy in their own location. The correlation in the predicted policy-induced change in the number of establishments and wages in shown in Figure 11. There is a positive correlation between the two, though as is clear from the figure the dispersion is very high, suggesting that predicted changes in the number of establishments do not have strong explanatory power for wage effects. This suggests that attempting to find individual factors predictive of the changes in establishment numbers or wages may be of use, since the goal of a place-based policy may be to increase wages or to increase employment.

Figure 12 shows the relationship between the elasticity of labor supply within a commuting zone and the predicted change in establishment counts and wages in Panels A and B respectively. The level of market power in a location is highly predictive of the response to a place-based policy in terms of the growth in the number of establishments. This suggests that if policymakers are interested in revitalizing underdeveloped regions, place-based policies are a possible tool in their arsenal if they are interested in growing the number of establishments. This is likely also correlated with employment effects, though this paper is not analyzing employment effects directly.

The model is not prescriptive about the relationship between μ_c and the changes in establishment counts induced by the policy. Algebraic manipulation of the definition of the percentage change in establishments yields

$$\text{Pct. Change in Estabs.}_c \equiv \frac{n_{c,cf} - n_{c,actual}}{n_{c,actual}}$$

$$= \frac{s_{c,cf}}{s_{c,actual}} \frac{s_{0,actual}}{s_{0,cf}} \frac{n_{0,cf}}{n_{0,actual}} - 1 \tag{17}$$

Taking the derivative of this expression with respect to μ_c yields:

$$\frac{\partial \text{Pct. Change in Estabs.}}{\partial \mu_c} = \frac{s_{c,cf}}{s_{c,actual}} \frac{s_{0,actual}}{s_{0,cf}} \ln\left[\frac{\beta_{c,CF} - b_{c,CF}}{\beta_{c,actual} - b_{c,actual}}\right] \tag{18}$$

The first two terms of this derivative, the shares, are by definition positive. Thus, the observed pattern of the percent change in establishments decreasing in μ_c must be coming from the final term of the derivative $\ln\left[\frac{\beta_{c,CF} - b_{c,CF}}{\beta_{c,actual} - b_{c,actual}}\right]$. Since this term is negative, it must be the case that in the counterfactuals, the difference between productivity and the outside option is narrowing. Either because spillovers decreasing or increasing outside options compared to the actual policy.

There are no variables which predict the changes in wages as clearly as market power predicts the changes in the number of establishments, though as seen in Panel B there is a slight correlation. Taken together, these results suggest that models assuming perfectly competitive labor markets may underpredict possible positive effects of place-based policies in the treated location. To test the assumption, I redo the counterfactual exercise assuming an elasticity of labor supply of 5[9], constant across locations.

The results are shown in Figure 13. Compared to the baseline results, assuming more perfectly competitive markets leads to much lower predicted benefits of a place-based policy within a location. In Panel A, the number of establishments is predicted to shrink by a very similar amount in most places, while the predicted wage-distribution is shifted downwards. Of note with the wage effects, though the predicted effects are lower the overall wage is still higher in the perfectly competitive world because wages are overall higher with higher labor market competition.

6 Conclusions

I develop a partial-equilibrium model of establishment-location choice incorporating corporate taxes, monopsonistic labor markets, and differential location productivity. I show that establishments in different economic sectors display different sensitivities to taxes, and differently value spillovers in their location decision. Most types of establishments prefer to pay lower wages as measured by the outside option, but some types of establishments are

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[9]The maximum in my data is 4.25

indifferent.

The effects of place-based policies are highly heterogeneous across space due to the secondary impact of spillovers, particularly with respect to the growth of establishments as seen in previous literature such as Devereux et al. (2007). The distribution of effects in the wage changes induced by a tax policy are largely positive, but the magnitude of changes varies greatly between locations. As demonstrated by the counterfactuals, small differences in initial conditions can leads to very different effects of the same place-based policy in different locations, making effective policy challenging. However, the evidence strongly suggests that smaller, less competitive locations derive more benefit from place-based policies than more highly developed ones.

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Figures

Figure 1: Input-Output Linkages Across Space, 1999
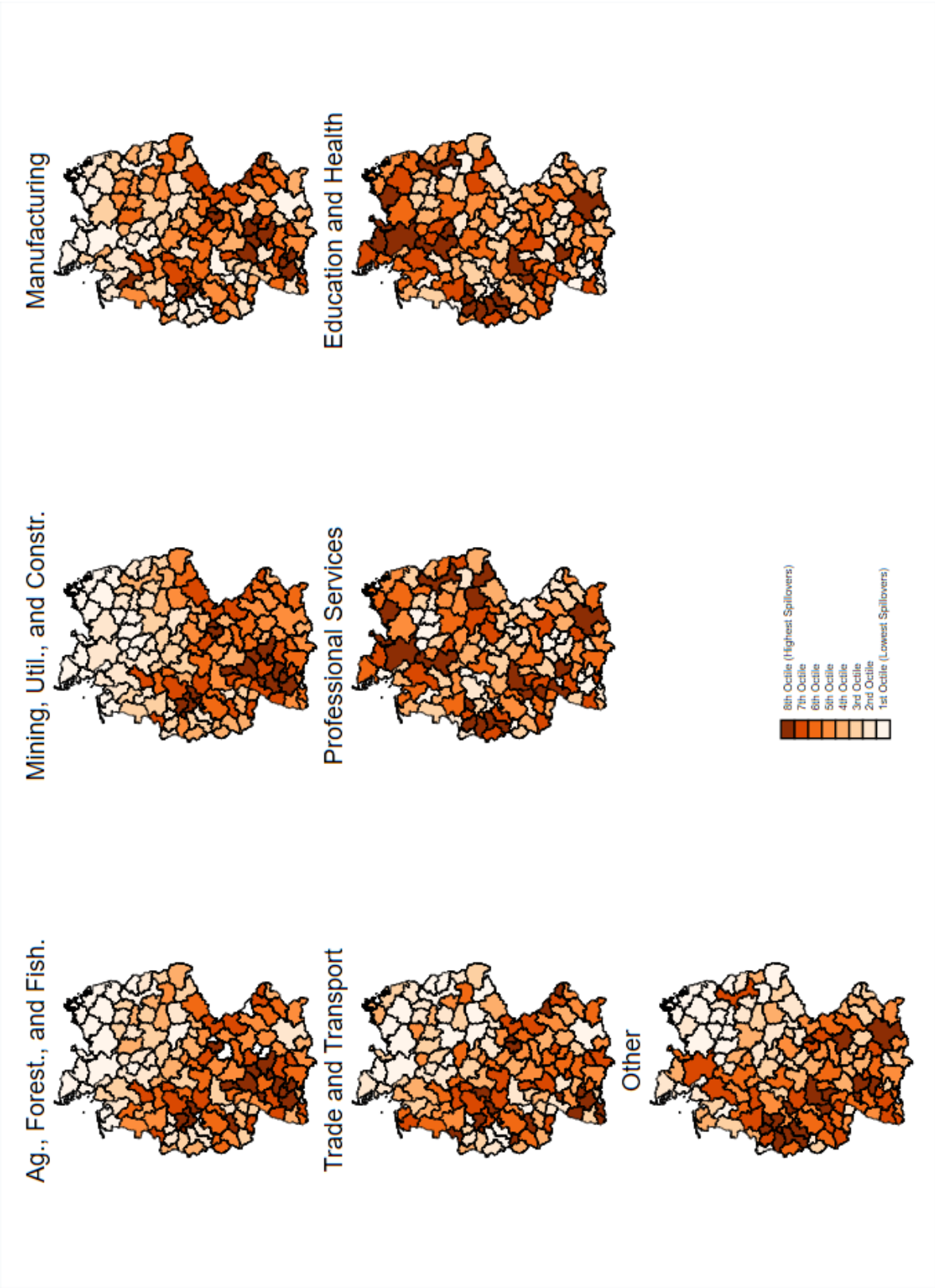
Notes: Figure shows octiles of the goods spillovers proxy within a commuting zone as calculated as a weighted average of national-level pairwise industrial input-output linkages using incumbent establishment industrial sector shares in the year 1999 as weights to aggregate to the commuting zone level. The pairwise sectoral values were calculated using the method described in Section 3.3.
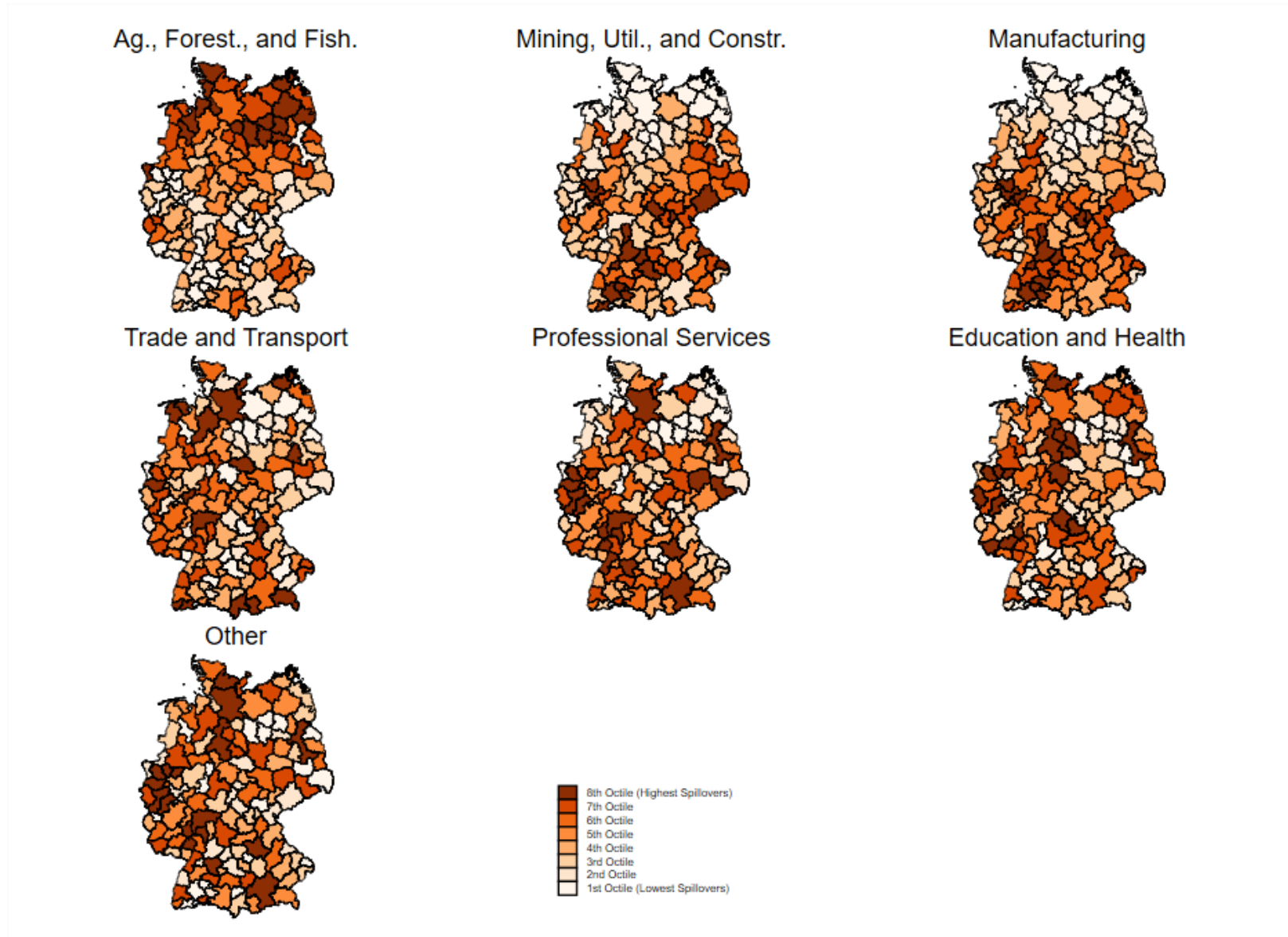
Figure 2: Labor Linkages Across Space, 1999


Notes: Figure shows octiles of the labor spillovers proxy within a commuting zone as calculated as a weighted average of national-level pairwise industrial correlations using incumbent establishment industrial sector shares in the year 1999 as weights to aggregate to the commuting zone level. The pairwise sectoral values were calculated using the method described in Section 3.4.

Figure 3: Average Corporate Tax Rates
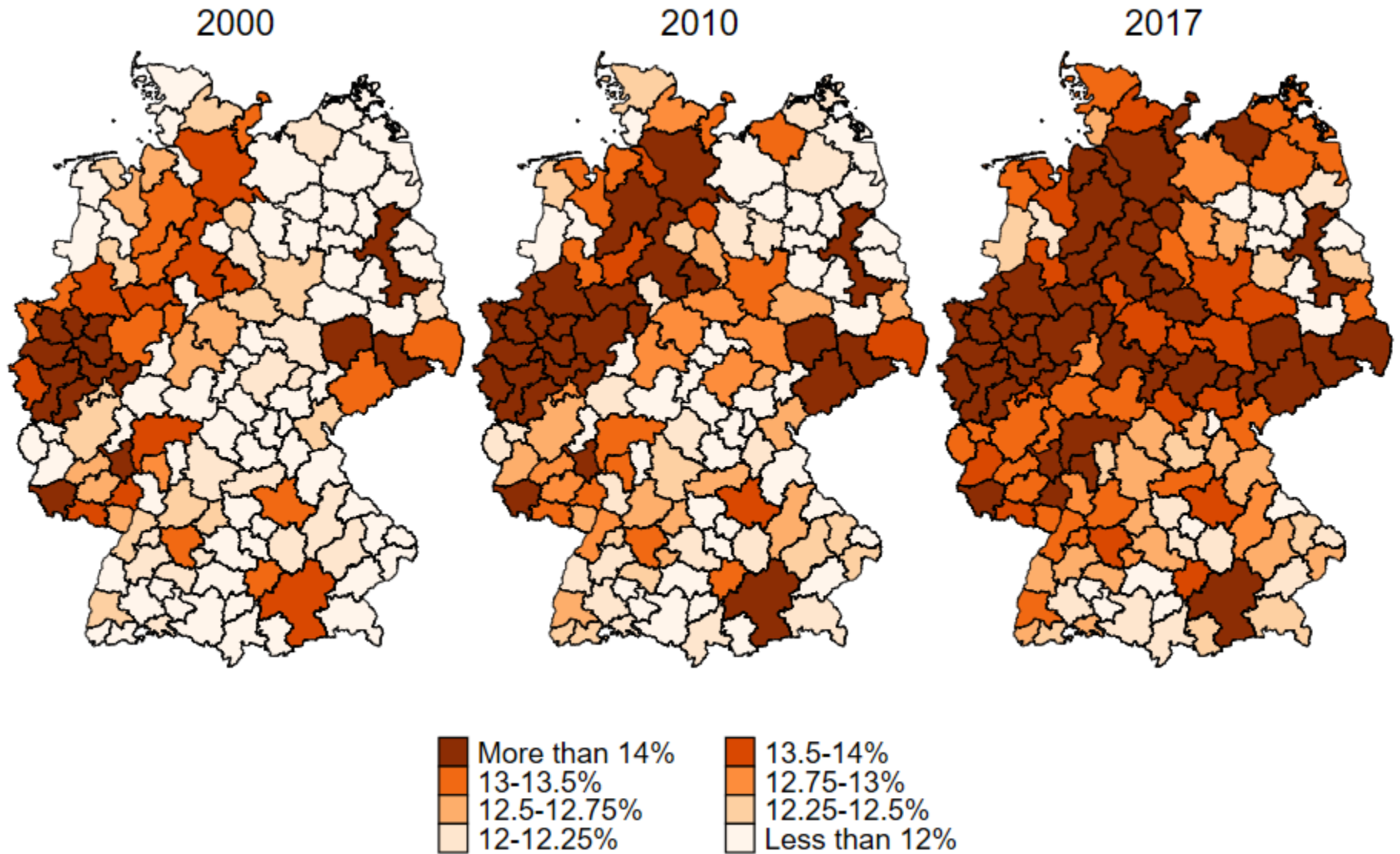
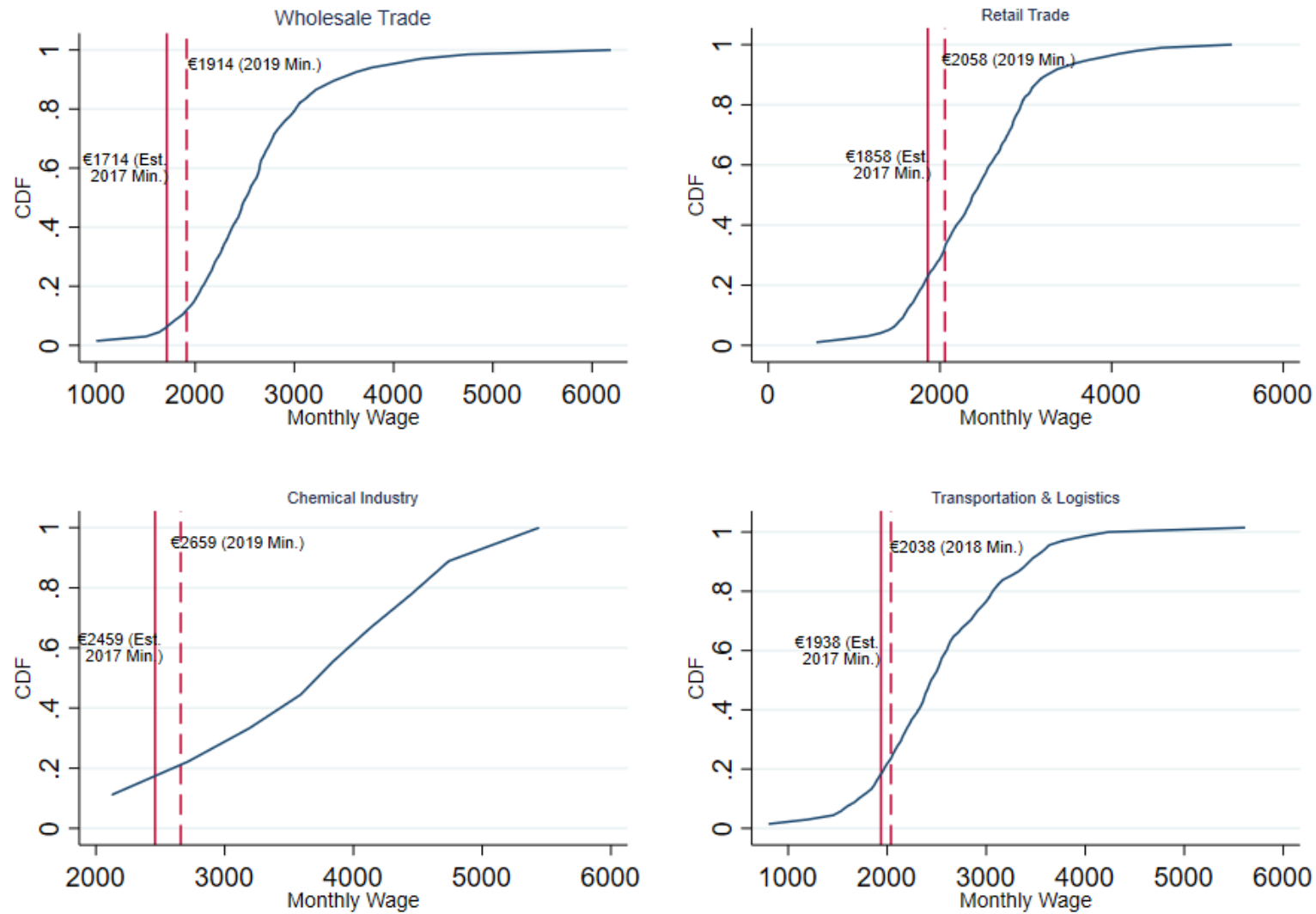Notes: Figure shows the average corporate tax rate within a commuting zone. Average values are weighted average of municipal corporate tax rate multipliers, with weights given by the number of residents in each municipality.

Figure 4: Imputing Union Minimum Wage Rates

Notes: Figure shows the CDF of the monthly wage levels in the BHP data for low-skill (with a lower secondary, intermediate secondary or upper secondary school leaving certificate but no vocational qualifications) workers at establishments with twenty or more employees in the state of North Rhine-Westphalia in the year 2017. Union minimum wage rates obtained from Tarifregister North Rhine-Westphalia on May 5, 2021, and are shown on the dashed red line, estimated 2017 union minimum wage rates estimated using the procedure described in Sector 3.6 and are shown by the solid red line.

Figure 5: Geographic Distribution of Outside Option
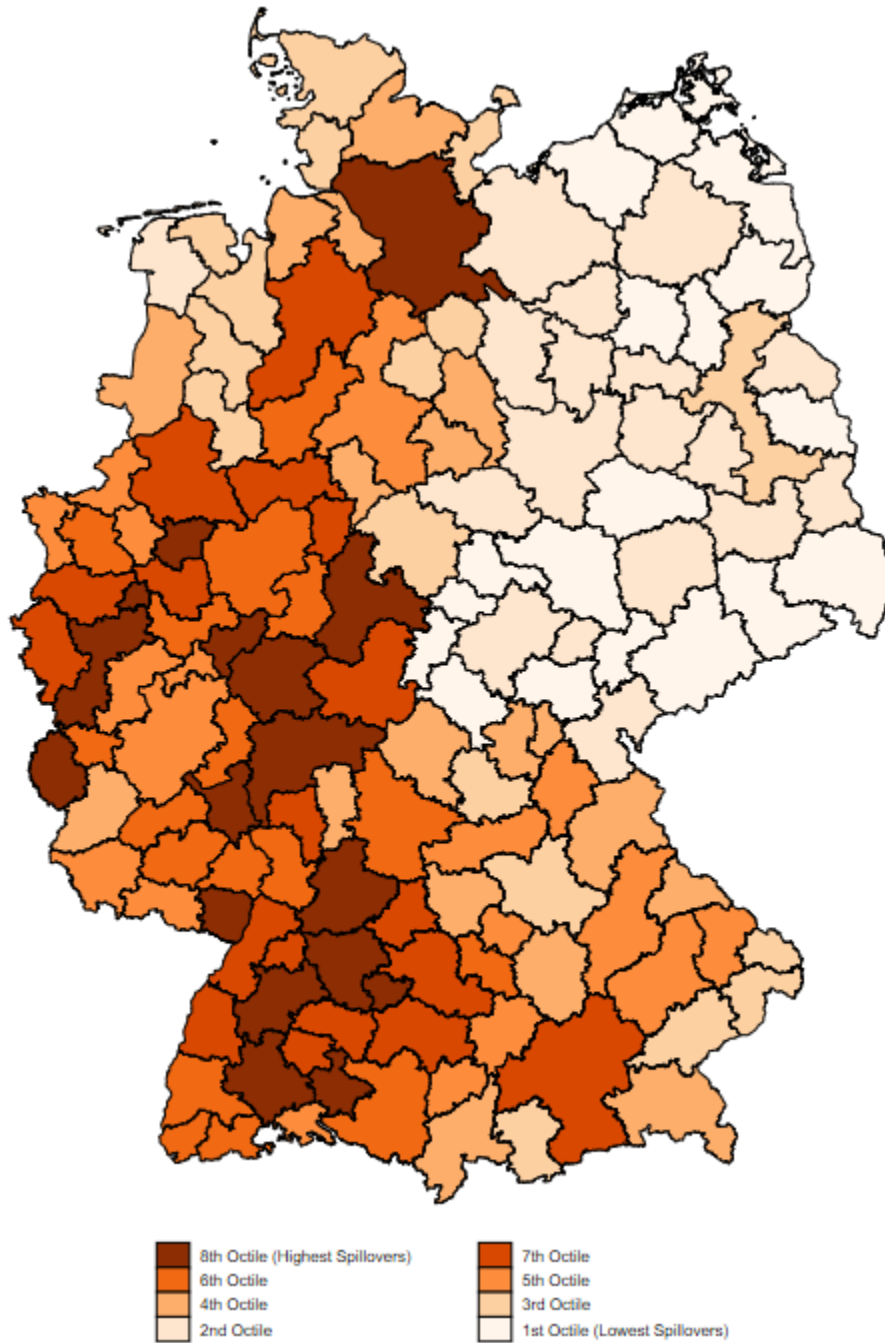
Notes: Figure shows octiles of outside option within a commuting zone for the year 1999. Outside option is calculated as a weighted average of state-level imputed union minimum wage rates using incumbent establishment industrial sector shares in the year 1999 as weights to measure at the commuting zone level. The imputed union minimum wage rates were calculated using the method described in Section 3.6.

Figure 6: Coefficients by Sector
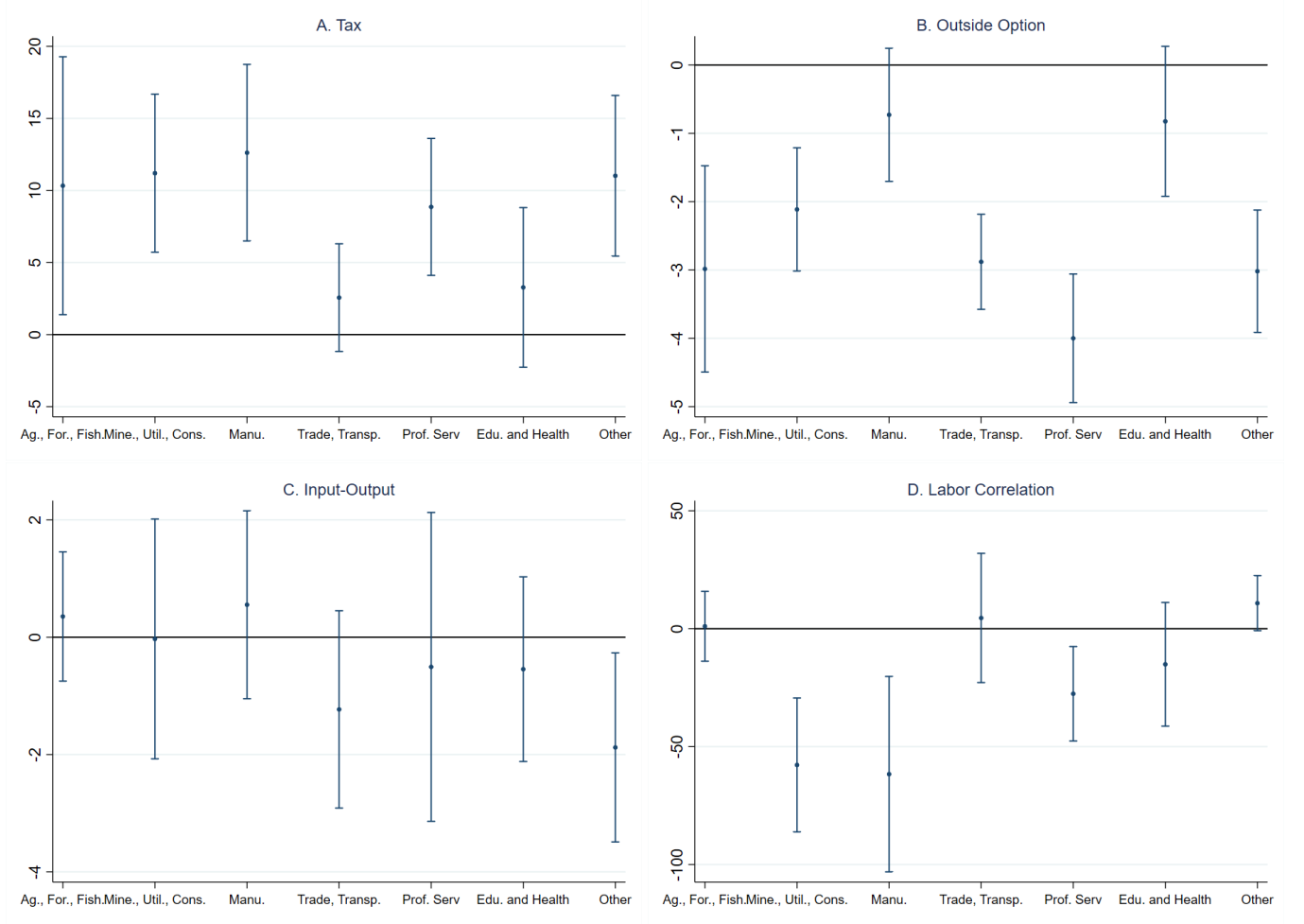
Notes: These figures show the point estimates of coefficients of the variables of interest for each industrial sector in the instrumental variable regression 10, as well as the 95% confidence intervals. The outcome variable is the log ratio of the share of new establishments locating in a location c compared to a base location 0 (Hamburg) - $\mu_c \ln(\mu_c)$. Tax, outside option, and input-output spillovers are log transformations, while the labor correlation spillovers are an inverse hyperbolic since transformation. All regressions include commuting zone and year fixed effects as well as controls for the market size parameter pre-estimated as outlined in Appendix Section C, share highly/medium qualified workers, share women, share full-time workers, share prime aged workers, and share German workers. Standard errors are clustered at the commuting-zone level.
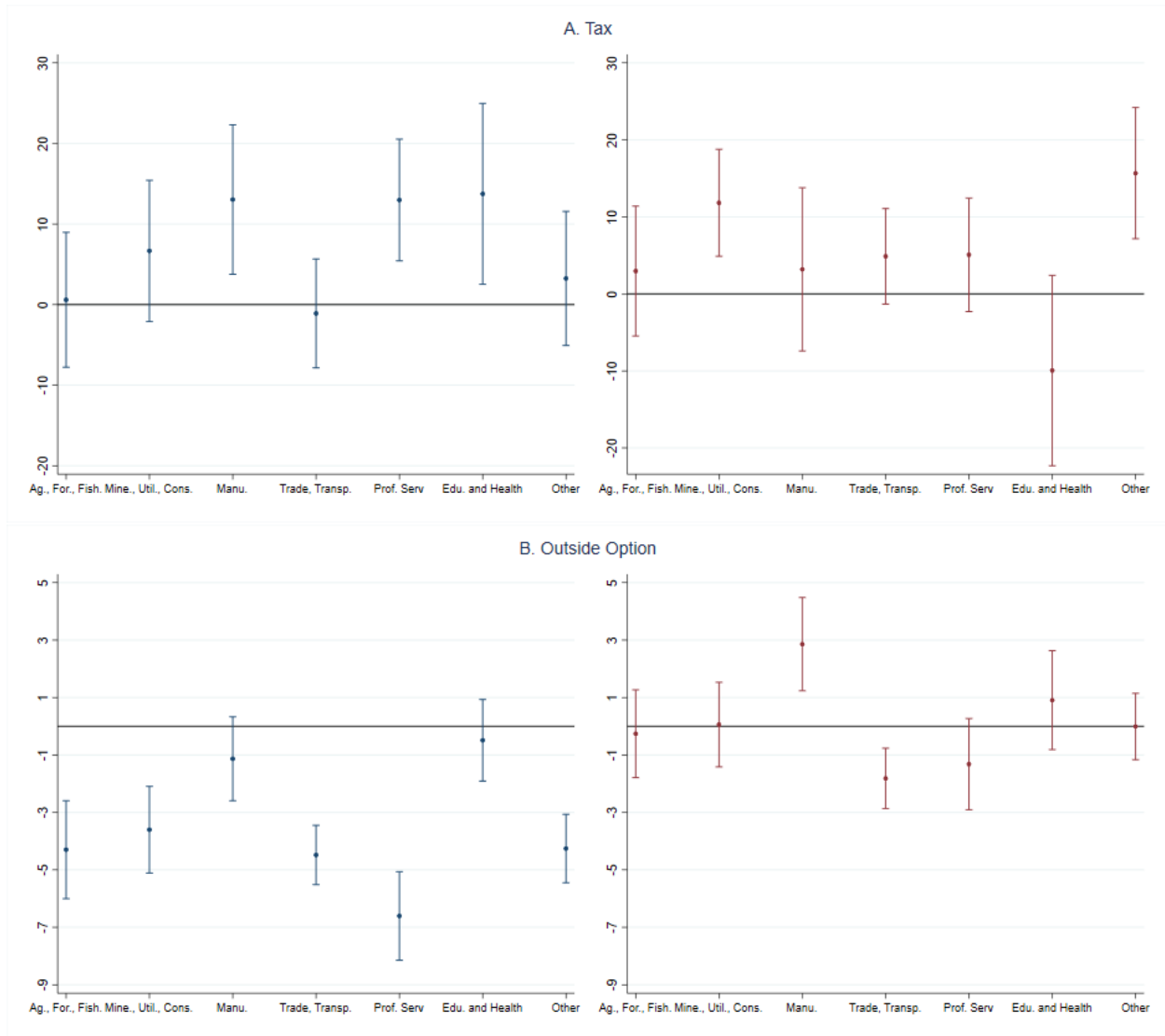
Figure 7: Coefficients: Splitting Sample by AKM Firm-Effect

Notes: These figures show the point estimates of coefficients of the variables of interest for each industrial sector in the instrumental variable regression 10, as well as the 95% confidence intervals. Sample is split by the AKM firm effect, with below-median AKM effect establishments shown in blue and above-median AKM effect establishments shown in red. Median AKM effect is defined at the sector-year level. The outcome variable is the log ratio of the share of new establishments locating in a location c compared to a base location 0 (Hamburg) - $\mu_c \ln(\mu_c)$. Tax, outside option, and input-output spillovers are log transformations, while the labor correlation spillovers are an inverse hyperbolic since transformation. All regressions include commuting zone and year fixed effects as well as controls for the market size parameter pre-estimated as outlined in Appendix Section C, share highly/medium qualified workers, share women, share full-time workers, share prime aged workers, and share German workers. Standard errors are clustered at the commuting-zone level.

Figure 8: Coefficients: Splitting Sample by Establishment Size
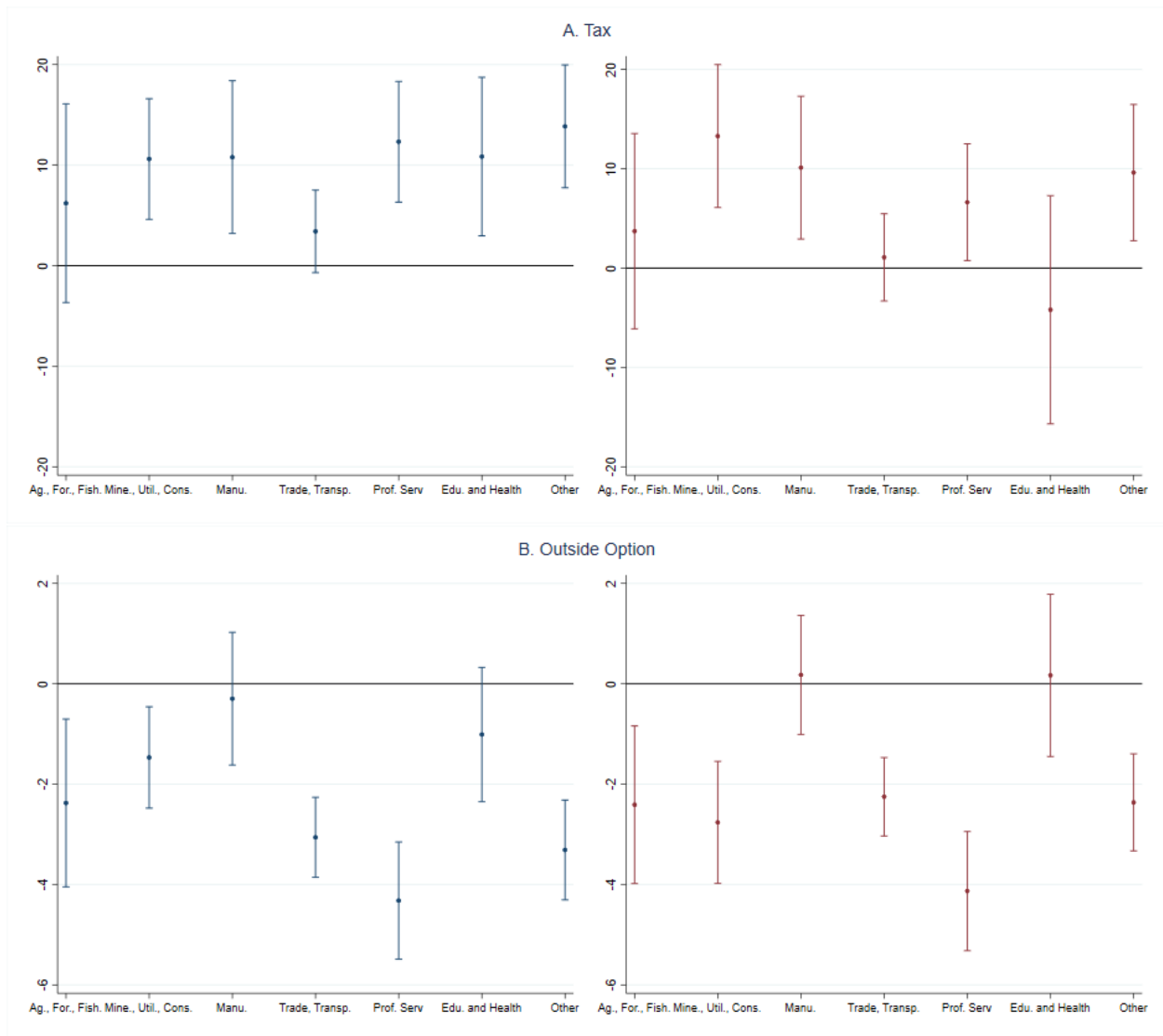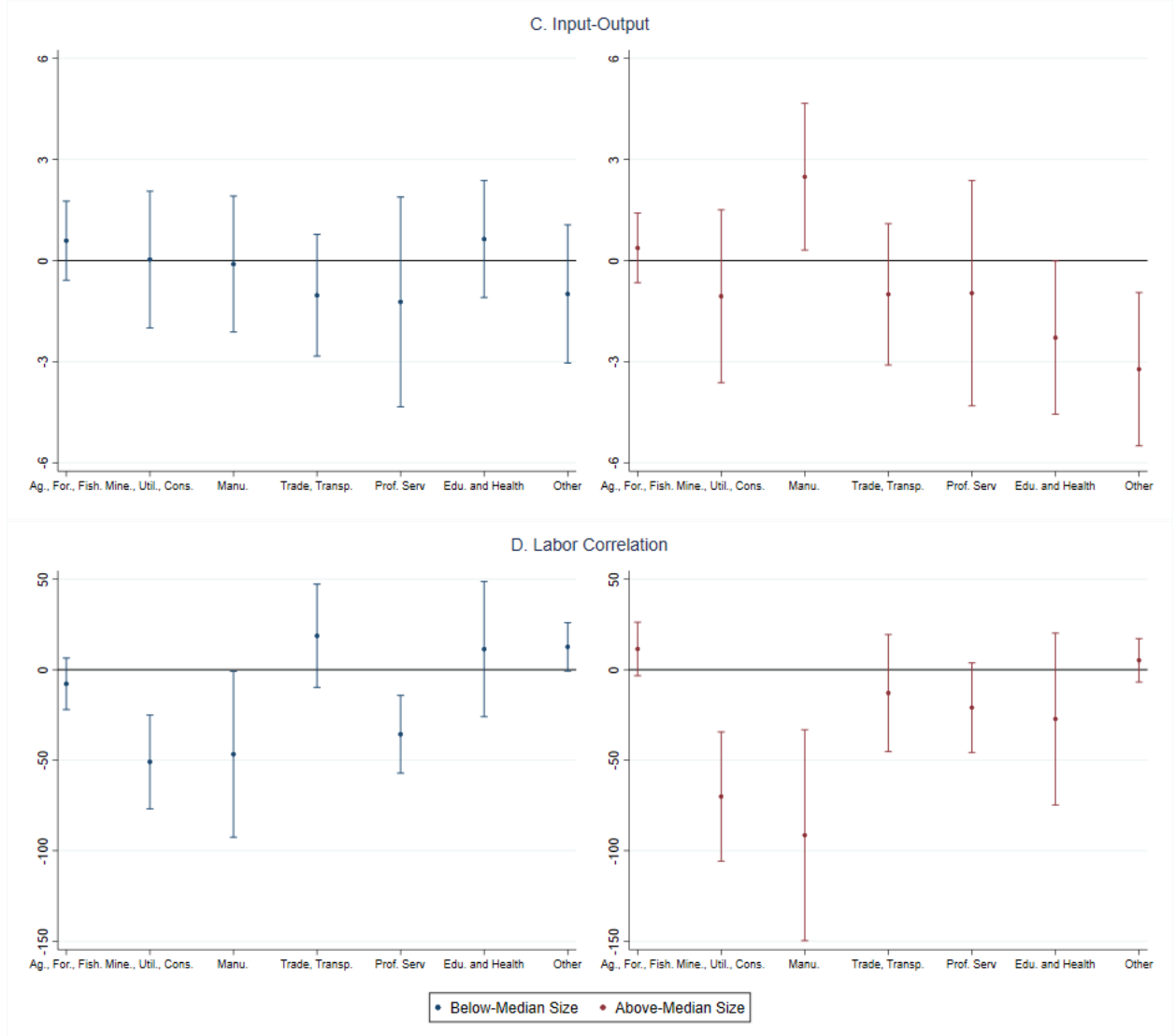
C. Input-Output

D. Labor Correlation

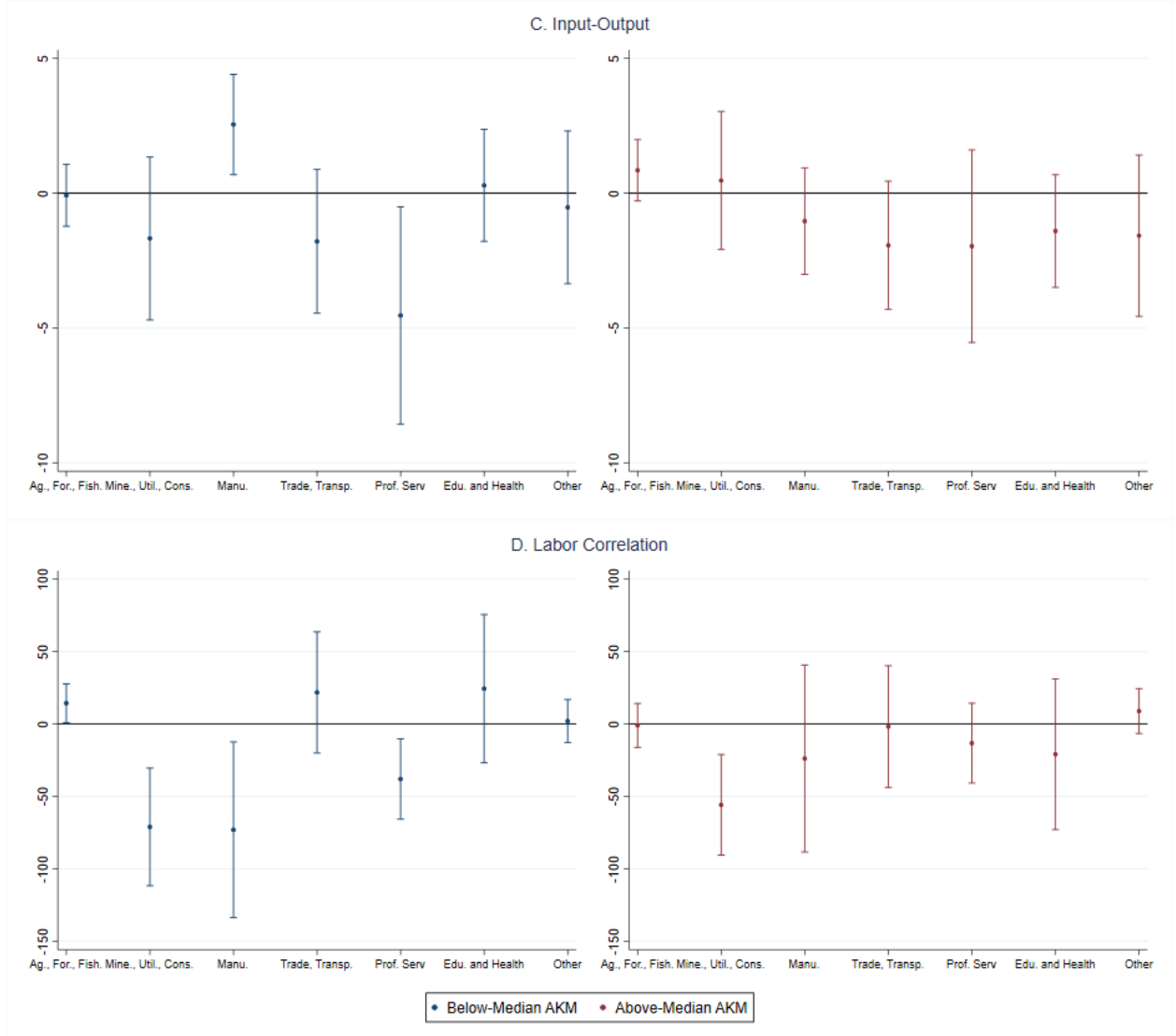• Below-Median Size   • Above-Median Size

Notes: These figures show the point estimates of coefficients of the variables of interest for each industrial sector in the instrumental variable regression 10, as well as the 95% confidence intervals. Sample is split by establishment size, where size is the total number of employees, with below-median size establishments shown in blue and above-median size establishments shown in red. Median size is defined at the sector-year level. The outcome variable is the log ratio of the share of new establishments locating in a location c compared to a base location 0 (Hamburg) - $\mu_c \ln(\mu_c)$. Tax, outside option, and input-output spillovers are log transformations, while the labor correlation spillovers are an inverse hyperbolic since transformation. All regressions include commuting zone and year fixed effects as well as controls for the market size parameter pre-estimated as outlined in Appendix Section C, share highly/medium qualified workers, share women, share full-time workers, share prime aged workers, and share German workers. Standard errors are clustered at the commuting-zone level.

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Figure 9: Illustration of Primary and Secondary Tax Policy Effects
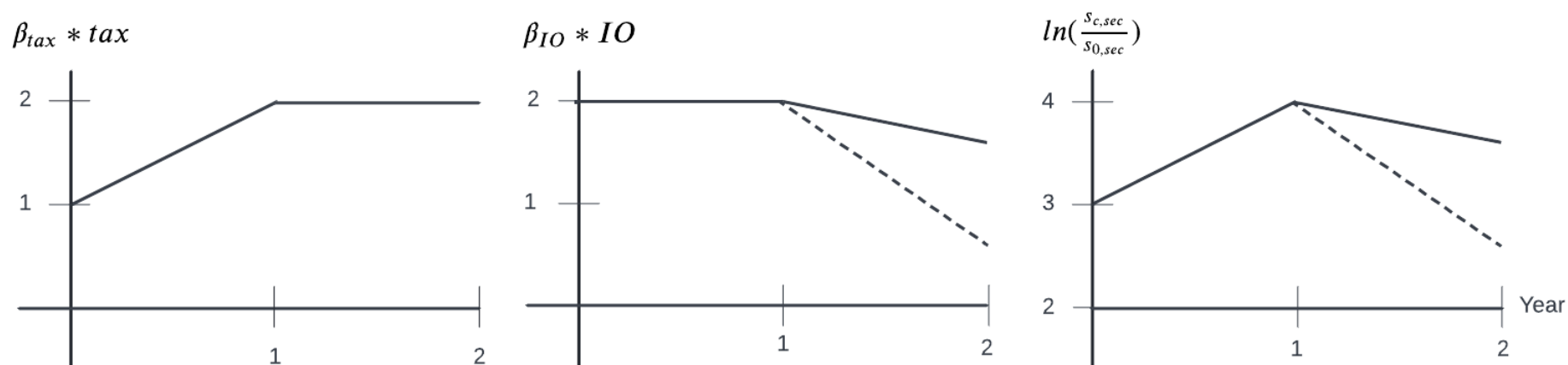
Notes: Time since a tax policy was enacted in t=0. When the tax rate decreases, the share ratio increases directly between time 0 and 1. Between time 1 and 2 the subsequent composition of establishments has changed, which leads to changes in the input-output spillovers. The solid and dashed lines show two possible paths, one of which leads to an overall decline in the share ratio despite the tax policy remaining in place.

Figure 10: Effects of Counterfactual Tax Policy on Commuting Zones
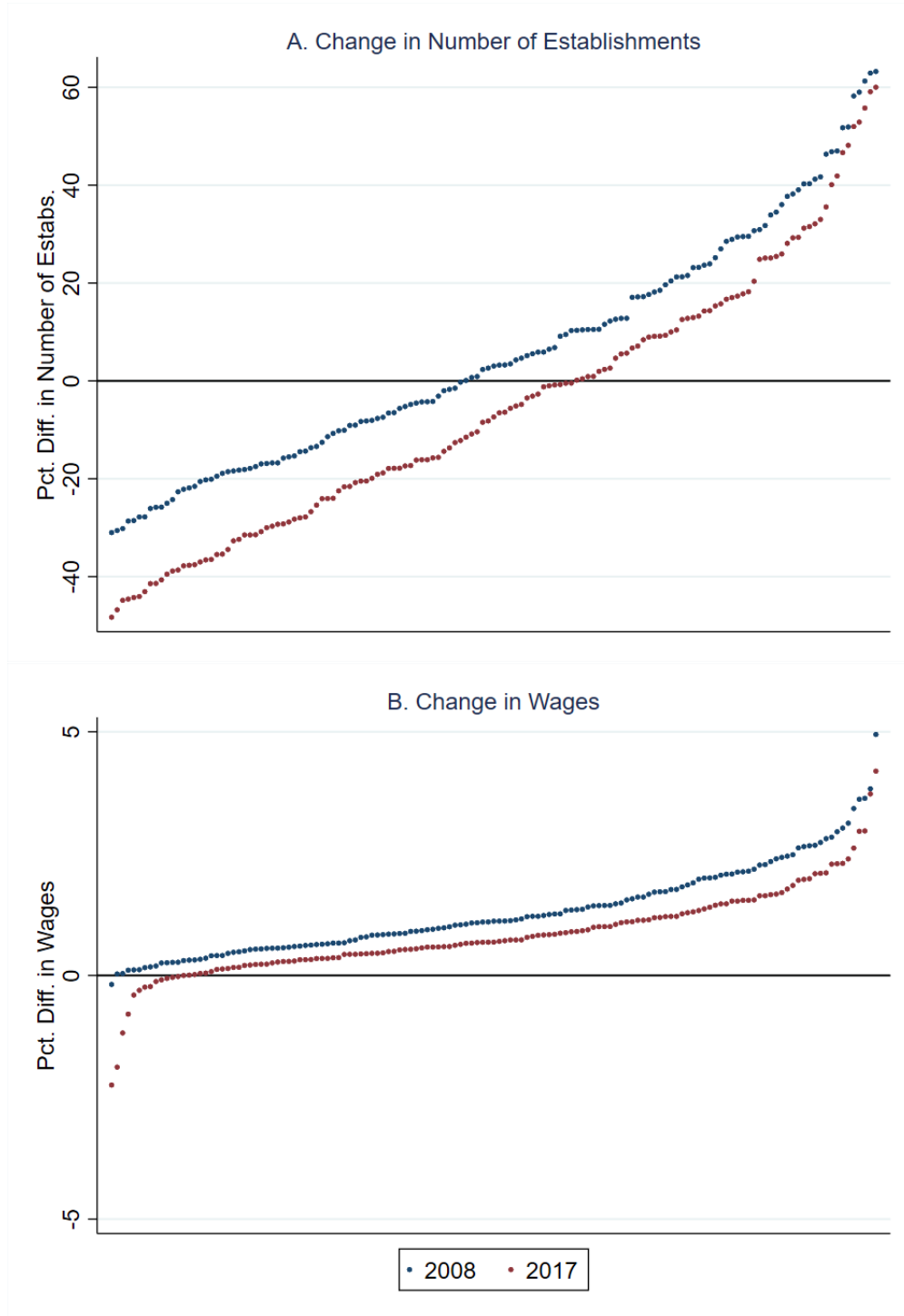
Notes: Each dot is a commuting zone. Panel A shows the percent difference in establishments under the counterfactual tax policy compared to the actual tax policy, and panel B the percent difference in wages. The effect of keeping the policy in place from 1999 to 2008 is shown in blue, while the effect of keeping the policy in place from 1999 until 2017 is shown in red. See Section 5 for details on calculations. The commuting zones with the lowest and highest change in number of establishments and wages were trimmed in the respective panels.

Figure 11: Correlation of Counterfactual Establishment and Wage Effects

Notes: Each dot is a commuting zone. On the x-axis is the percent difference in wages under the counterfactual tax policy compared to the actual tax policy in the year 2017, while on the y-axis is the difference in the number of establishments under the counterfactual tax policy compared ot he actual tax policy in 2017. The red line is the linear fit. The commuting zones with the lowest and highest change in number of establishments and wages were trimmed.

Figure 12: Correlation of Counterfactual Results and Market Power

A. Establishments

B. Wages
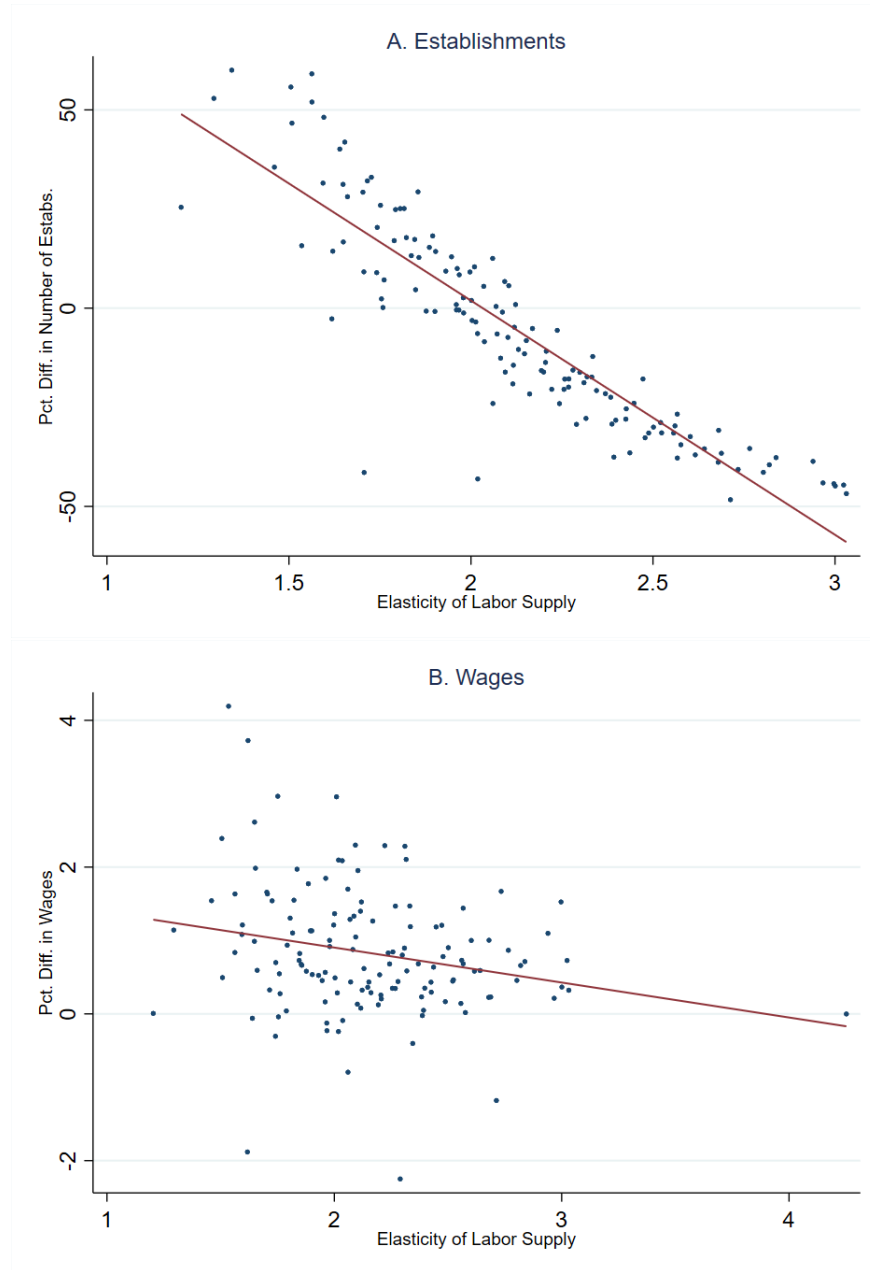
Notes: Each dot is a commuting zone. Panel A shows the relationship between the percent difference in the number of establishments under the counterfactual tax policy compared to the actual tax policy in the year 2017 and the elasticity of labor supply in the commuting zone μ_c, while Panel B shows the relationship with wages. See Appendix Section C for details on estimation of labor supply elasticities.

Figure 13: Effects of Counterfactual Tax Policy on Commuting Zones in a More Perfectly Competitive World
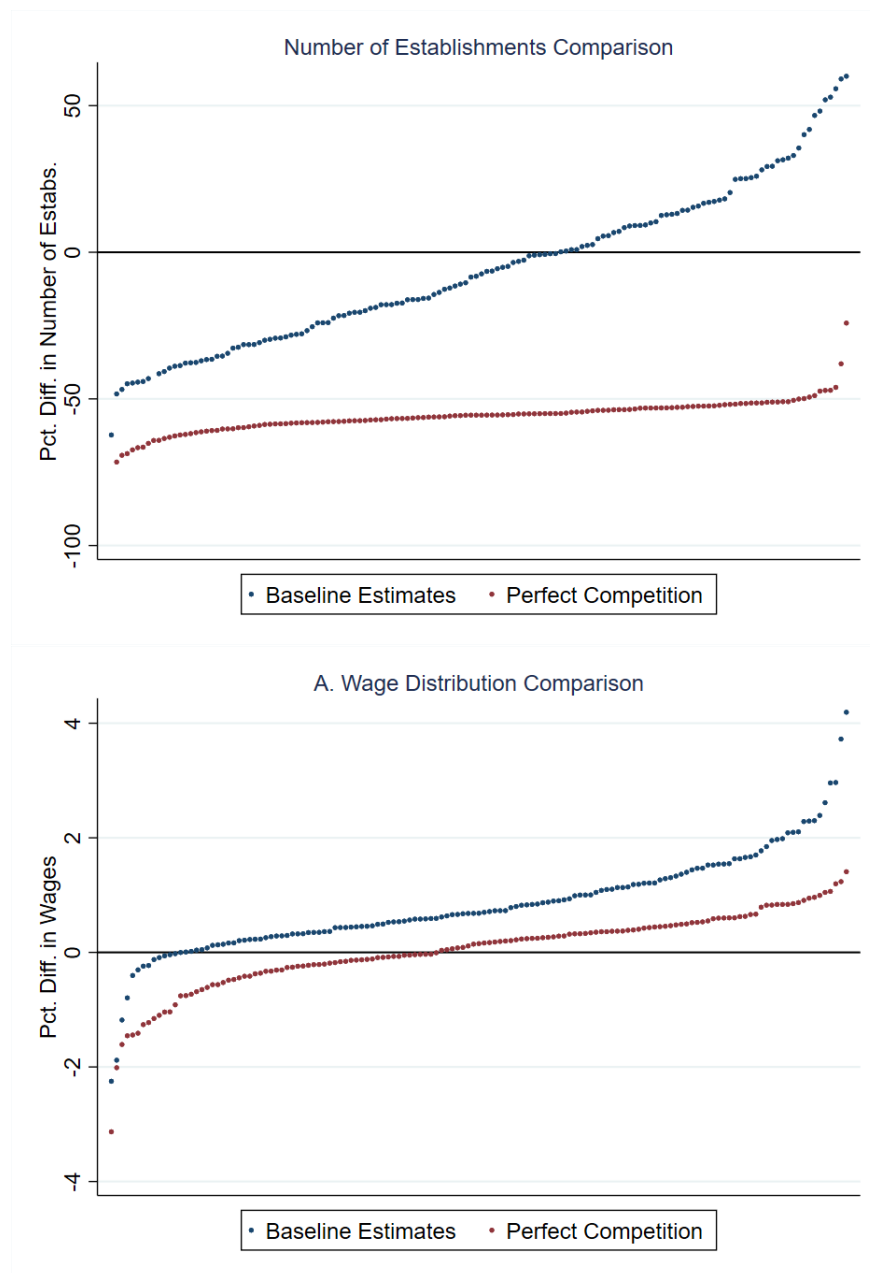
Notes: Each dot is a commuting zone. Panel A (B) shows the percent difference in establishments (wages) under the counterfactual tax policy compared to the actual tax policy for both the baseline estimates in Figure 10 and if the elasticity of labor supply was constant across space and markets were more competitive, setting $\mu_c=5$ in all commuting zones. The effect of keeping the policy in place from 1999 to 2008 is shown in blue, while the effect of keeping the policy in place from 1999 until 2017 is shown in red. See Section 5 for details on calculations. The commuting zones with the lowest and highest change in number of establishments and wages were trimmed.

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Tables

Table 1: BHP Summary Statistics

| Sector	1999	2008	2017
Agriculture, Forestry, and Fishing	1.83	1.85	1.8
Mining, Utilities, and Construction	14.44	11.25	14.22
Manufacturing	5.64	5.13	4.15
Trade and Transport	38.03	36.26	34.44
Professional Services	19.46	19.91	19.23
Education and Health	6.56	7.68	8.17
Other	14.05	17.92	17.98
Number of Employees			
1-4	82.15	76.86	69.96
5-9	10.72	13.73	16.84
10-19	4.44	5.75	7.98
20-49	1.96	2.63	3.94
50-99	0.51	0.72	0.94
100-199	0.16	0.22	0.23
200+	0.06	0.09	0.11
Total Entrants	94,537	61,888	37,972

Notes: This table shows summary statistics for new establishments in the BHP.

Table 2: Overview of data

Additional variables merged to the establishment data

Target Variable	Proxied Using	Source
Spillovers	Follows Ellison, Glaeser, and Kerr (2010)	
Goods	Input-Output Tables	German statistical library
Labor	Vector correlation of occupational shares between two industries	Linked employer-employee data (SIAB)
Knowledge	Measure from Jaffe et al. (1993)	OECD Patent Database
Taxes	Weighted average of municipal corporate tax rates within the commuting zone. A multiplier of the federal tax rate.	German statistical library
Outside Option - Estimated Average Union Contract Minimum	20th percentile of establishment-median low-skill workers wages in an industry-state cell in the BHP	Derived using the BHP, union contracts obtained from Tarifregister Nordrhein-Westfalen

Table 3: Response of the Share Ratio to Taxes, Spillovers, and Outside Option

	Ag. For. Fish.	Mine., Util., Constr.	Manu.	Trade, Transport	Prof. Serv.	Edu., Health.	Other
Tax	10.33**	11.20***	12.62***	2.566	8.860***	3.276	11.02***
	(4.565)	(2.797)	(3.126)	(1.905)	(2.424)	(2.825)	(2.844)
Outside Option	-2.984***	-2.113***	-0.729	-2.880***	-3.999***	-0.824	-3.018***
	(0.770)	(0.460)	(0.497)	(0.355)	(0.480)	(0.560)	(0.457)
Input-Output	0.353	-0.0295	0.553	-1.231	-0.506	-0.545	-1.879**
	(0.562)	(1.043)	(0.817)	(0.858)	(1.343)	(0.803)	(0.822)
Labor Correlation	1.027	-57.77***	-61.67***	4.560	-27.58***	-15.09	10.84*
	(7.560)	(14.49)	(21.14)	(13.98)	(10.22)	(13.38)	(5.958)
Knowledge	-0.0136	0.0264	0.0747**	0.00442	0.0127	0.00466	0.0202
	(0.0609)	(0.0267)	(0.0312)	(0.0191)	(0.0253)	(0.0304)	(0.0221)
N	2561	2660	2637	2660	2657	2654	2660
F	11.23	78.98	63.45	179.1	95.42	47.02	88.19

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Results of the IV empirical specification equation (10) with spillover and outside option instruments constructed as shown in equation (13). Each column is an industrial sector. The outcome variable is the log ratio of the share of new establishments locating in a location c compared to a base location 0 (Hamburg) - $\mu_c \ln(\mu_c)$. Tax, outside option, and input-output spillovers are log transformations, while the labor correlation spillovers are an inverse hyperbolic since transformation. All regressions include commuting zone and year fixed effects as well as controls for the market size parameter pre-estimated as outlined in Appendix Section C, share highly/medium qualified workers, share women, share full-time workers, share prime aged workers, and share German workers. Standard errors are clustered at the commuting-zone level. See section 3 for details on the construction of the variables of interest.

Table 4: Response of the Share Ratio to Taxes, Spillovers, and Outside Option: Alternative Sector Definition

	Ag. For. Fish.	Mine., Util., Constr.	Goods Manu.	Chem., Pharm. Manu.	Metal. Manu.	Elec. Manu.	Mach. Manu.	Other Manu.
Tax	5.910	9.190***	0.621	5.508	4.495	-2.932	8.225*	8.003*
	(4.368)	(2.472)	(4.392)	(5.261)	(4.425)	(5.391)	(4.421)	(4.419)
Outside Option	-4.093***	-4.107***	0.881	-2.270**	-1.545*	-1.515	-0.559	1.919*
	(1.341)	(0.714)	(1.302)	(0.987)	(0.920)	(1.304)	(1.209)	(1.147)
Input-Output	-1.033***	-1.793	-2.209**	0.0181	-0.473	0.829	-0.426	0.645**
	(0.244)	(1.336)	(0.974)	(0.898)	(0.411)	(1.372)	(0.762)	(0.251)
Labor Correlation	33.64***	-7.396	-12.06	-62.17**	-30.44	28.67**	-4.621	-80.05***
	(10.20)	(5.156)	(25.09)	(26.57)	(33.37)	(11.38)	(19.44)	(21.06)
Knowledge	-0.0194	0.0235	-0.00394	0.0246	0.112***	0.0830	0.0233	0.0216
	(0.0620)	(0.0265)	(0.0453)	(0.0663)	(0.0435)	(0.0681)	(0.0579)	(0.0595)
N	2561	2660	2381	1978	2390	1624	2001	2004
F	7.397	89.16	22.69	18.04	23.74	14.26	24.27	17.03

	Trade	Trans., Logis.	Arts, Rec.	Media, Comm.	Tech. Serv.	Bus. Serv.	Edu., Health	Other
Tax	1.183	2.816	3.471	4.527	3.758	3.800	4.294**	6.778**
	(2.491)	(2.895)	(4.390)	(6.664)	(3.033)	(3.219)	(2.059)	(2.665)
Outside Option	-6.137***	-4.002***	-9.111***	-1.430	-5.250***	-4.211***	-1.249	-2.807***
	(0.667)	(0.807)	(1.121)	(1.095)	(0.900)	(0.653)	(0.813)	(0.564)
Input-Output	1.363***	0.469	1.001***	5.012**	1.288*	-0.708	0.114***	-1.383***
	(0.338)	(0.453)	(0.247)	(2.203)	(0.740)	(0.820)	(0.0416)	(0.464)
Labor Correlation	-12.08	-4.913	-30.03***	-54.35**	-58.42**	-38.24***	-4.859	-11.35*
	(8.451)	(16.03)	(10.24)	(21.69)	(28.10)	(12.31)	(14.74)	(6.704)
Knowledge	0.00643	-0.0602*	0.0917*	-0.0147	0.00528	-0.00401	0.00709	0.00293
	(0.0185)	(0.0332)	(0.0552)	(0.0607)	(0.0349)	(0.0383)	(0.0297)	(0.0231)
N	2660	2615	2423	2098	2636	2645	2654	2659
F	81.02	48.04	227.4	18.66	59.14	70.30	48.66	84.17

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Results of the IV empirical specification equation (10) with spillover and outside option instruments constructed as shown in equation (13). Each column is an industrial sector. The outcome variable is the log ratio of the share of new establishments locating in a location c compared to a base location 0 (Hamburg) - $\mu_c \ln(\mu_c)$. Tax, outside option, and input-output spillovers are log transformations, while the labor correlation spillovers are an inverse hyperbolic since transformation. All regressions include commuting zone and year fixed effects as well as controls for the market size parameter pre-estimated as outlined in Appendix Section C, share highly/medium qualified workers, share women, share full-time workers, share prime aged workers, and share German workers. Standard errors are clustered at the commuting-zone level. See section 3 for details on the construction of the variables of interest.

Table 5: Share of Establishments Within Sector by Tradability Group

	Non Tradable	Low Tradability	Medium Tradability	High Tradability
Ag. For. Fish.	0.00	0.00	10.55	89.45
Mine., Util., Constr.	15.06	77.86	7.03	0.05
Manufacturing	0.00	0.00	55.93	44.07
Trade, Transport	86.55	13.45	0.00	0.00
Prof. Serv.	69.07	12.53	18.40	0.00
Edu., Health.	100.00	0.00	0.00	0.00
Other	70.18	7.42	22.39	0.00

Notes: Each row shows the percent of establishments in the industrial sector which in non-, low-, medium-, and high-tradability two-digit industries. Tradability definitions are from Dauth et al. (2017). The tradability index is level of import penetration and export opportunities at the two-digit-industry level. Non-tradable industries are those below the 10th percentile, low tradable those between the 10th and 40th percentile, medium tradable those between the 40th and 70th, and highly tradable those above the 70th percentile.

Table 6: Heterogeneity of Results by AKM Firm Effect

Panel A: Above-Median AKM Effect

	Ag. For. Fish.	Mine., Util., Constr.	Manu.	Trade, Transport	Prof. Serv.	Edu., Health.	Other
Tax	2.965	11.83***	3.184	4.882	5.074	-9.949	15.68***
	(4.304)	(3.544)	(5.408)	(3.163)	(3.763)	(6.307)	(4.345)
Outside Option	-0.261	0.0584	2.858***	-1.814***	-1.322	0.908	-0.00982
	(0.780)	(0.751)	(0.828)	(0.535)	(0.811)	(0.878)	(0.589)
Input-Output	0.850	0.472	-1.037	-1.933	-1.967	-1.404	-1.578
	(0.580)	(1.307)	(1.008)	(1.213)	(1.823)	(1.066)	(1.526)
Labor Correlation	-0.982	-55.84***	-23.84	-1.801	-13.24	-20.90	8.918
	(7.738)	(17.73)	(32.97)	(21.45)	(14.07)	(26.55)	(7.912)
Knowledge	0.00782	0.00810	-0.0511	-0.0515*	0.0384	-0.0325	0.00771
	(0.0626)	(0.0343)	(0.0601)	(0.0302)	(0.0401)	(0.0525)	(0.0573)
N	1426	2590	2179	2641	2456	2302	2551
F	17.45	26.38	27.47	48.51	28.21	18.01	30.68

Panel B: Below-Median AKM Effect

	Ag. For. Fish.	Mine., Util., Constr.	Manu.	Trade, Transport	Prof. Serv.	Edu., Health.	Other
Tax	0.593	6.658	13.04***	-1.098	12.98***	13.74**	3.244
	(4.269)	(4.474)	(4.733)	(3.451)	(3.855)	(5.729)	(4.246)
Outside Option	-4.298***	-3.602***	-1.133	-4.483***	-6.605***	-0.488	-4.258***
	(0.870)	(0.769)	(0.745)	(0.527)	(0.787)	(0.724)	(0.608)
Input-Output	-0.0773	-1.680	2.549***	-1.787	-4.537**	0.290	-0.526
	(0.586)	(1.542)	(0.950)	(1.361)	(2.056)	(1.059)	(1.445)
Labor Correlation	14.34**	-71.11***	-73.10**	21.79	-38.04***	24.39	2.034
	(6.813)	(20.74)	(30.98)	(21.35)	(14.16)	(26.12)	(7.588)
Knowledge	-0.0554	0.0297	0.0807*	0.0328	-0.0388	0.0866*	-0.00241
	(0.0623)	(0.0593)	(0.0469)	(0.0332)	(0.0483)	(0.0483)	(0.0401)
N	1479	2547	2332	2656	2569	2424	2550
F	34.67	19.86	24.12	52.00	33.22	25.74	17.69

$^{*}\ p < 0.1$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

Notes: Results of the IV empirical specification equation (10) with spillover and outside option instruments constructed as shown in equation (13). Each column is an industrial sector. The sample is split by AKM firm effect, with the median value defined at the sector-year level. The outcome variable is the log ratio of the share of new establishments locating in a location c compared to a base location 0 (Hamburg) - $\mu_c \ln(\mu_c)$. Tax, outside option, and input-output spillovers are log transformations, while the labor correlation spillovers are an inverse hyperbolic since transformation. All regressions include commuting zone and year fixed effects as well as controls for the market size parameter pre-estimated as outlined in Appendix Section C, share highly/medium qualified workers, share women, share full-time workers, share prime aged workers, and share German workers. Standard errors are clustered at the commuting-zone level. See section 3 for details on the construction of the variables of interest.

Table 7: Heterogeneity of Results by Establishment Size

Panel A: Above-Median Size

	Ag. For. Fish.	Mine., Util., Constr.	Manu.	Trade, Transport	Prof. Serv.	Edu., Health.	Other
Tax	3.716	13.29***	10.11***	1.077	6.631**	-4.199	9.611***
	(5.015)	(3.669)	(3.667)	(2.240)	(2.999)	(5.860)	(3.497)
Outside Option	-2.411***	-2.761***	0.178	-2.252***	-4.132***	0.168	-2.363***
	(0.801)	(0.620)	(0.605)	(0.399)	(0.606)	(0.825)	(0.493)
Input-Output	0.377	-1.058	2.489**	-1.002	-0.969	-2.287**	-3.223***
	(0.527)	(1.309)	(1.111)	(1.070)	(1.705)	(1.162)	(1.161)
Labor Correlation	11.47	-70.12***	-91.47***	-12.91	-20.98*	-27.27	5.163
	(7.552)	(18.22)	(29.73)	(16.51)	(12.63)	(24.23)	(6.128)
Knowledge	-0.110*	0.00124	0.0632	0.00931	0.0103	-0.0219	0.0273
	(0.0628)	(0.0378)	(0.0456)	(0.0268)	(0.0375)	(0.0442)	(0.0357)
N	2143	2634	2535	2659	2619	2586	2634
F	17.79	41.91	31.24	104.6	54.38	32.33	61.65

Panel B: Below-Median Size

	Ag. For. Fish.	Mine., Util., Constr.	Manu.	Trade, Transport	Prof. Serv.	Edu., Health.	Other
Tax	6.218	10.61***	10.80***	3.414	12.33***	10.85***	13.86***
	(5.043)	(3.063)	(3.875)	(2.092)	(3.062)	(4.023)	(3.117)
Outside Option	-2.375***	-1.468***	-0.297	-3.060***	-4.321***	-1.011	-3.312***
	(0.853)	(0.516)	(0.675)	(0.407)	(0.596)	(0.683)	(0.508)
Input-Output	0.590	0.0314	-0.103	-1.029	-1.229	0.639	-0.990
	(0.599)	(1.035)	(1.029)	(0.922)	(1.588)	(0.886)	(1.046)
Labor Correlation	-7.784	-50.93***	-46.73**	18.74	-35.70***	11.37	12.63*
	(7.252)	(13.23)	(23.39)	(14.54)	(10.96)	(19.06)	(6.833)
Knowledge	0.0402	0.0380	0.0378	0.0155	0.0190	0.000900	0.0327
	(0.0662)	(0.0273)	(0.0389)	(0.0224)	(0.0321)	(0.0381)	(0.0311)
N	2385	2659	2575	2658	2653	2631	2653
F	6.221	56.54	37.13	154.8	63.94	34.71	60.01

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Results of the IV empirical specification equation (10) with spillover and outside option instruments constructed as shown in equation (13). Each column is an industrial sector. The sample is split by establishment size (number of employees) with the median value defined at the sector-year level. The outcome variable is the log ratio of the share of new establishments locating in a location c compared to a base location 0 (Hamburg) - $\mu_c \ln(\mu_c)$. Tax, outside option, and input-output spillovers are log transformations, while the labor correlation spillovers are an inverse hyperbolic since transformation. All regressions include commuting zone and year fixed effects as well as controls for the market size parameter pre-estimated as outlined in Appendix Section C, share highly/medium qualified workers, share women, share full-time workers, share prime aged workers, and share German workers. Standard errors are clustered at the commuting-zone level. See section 3 for details on the construction of the variables of interest.

Table 8: Model Fit - Comparing Imputed and Actual Wages

	Average Wage
Imputed Wage	1.43***
constant	-8.89
N	18,622
R2	.426

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Outcome variable is the average daily wage in the sector-commuting zone-year cell. The imputed wage is calculated as shown in equation (6). Sector-commuting zone-year productivity is backed out by equating the productivity term of model equation (9) and the post-estimation predicted shares minus year fixed effects, market size, and tax portions of the estimating equation (10).

A Conditional Equivalence Between Logit and Poisson

Guimarães et al. (2003) propose an alternative computationally tractable approach to estimating a firm location decision problem. Starting from the log-likelihood of the traditional maximum likelihood estimation of the logit choice problem:

$$\log(L_{cmt}) = \sum_{c=1}^{C} n_{cmt} \log(p_{cmt}) \tag{1}$$

Starting with the assumption that the distribution of counts of establishments picking a certain location is distributed poisson:

$$E(n_{cmt}) = \lambda_{ctm} = \exp(\alpha + y_{ctm}) \tag{2}$$

where y_{ctm} is is the log-profit offered by a location as in Equation (7). Given the probability mass function of the poissson distribution $Pr(n = n_{cmt}) = \frac{\lambda^{n_{cmt}} \exp(-\lambda_{ctm})}{n_{ctm}!}$, the poisson log-likelihood is:

$$\log(L_p) = \sum_{c=1}^{C} (-\lambda_{ctm} + n_{cmt} \log(\lambda_{cmt}) - \log(n_{cmt}!)) \tag{3}$$

After taking the first order condition with respect to α and rearranging Guimaraes et al. (2003) shows that the poisson log likelihood is:

$$\log(L_p) = \sum_{c=1}^{C} n_{cmt} \log(p_{cmt}) - N + N \log(N) - \sum_{c=1}^{C} \log(n_{cmt}!) \tag{4}$$

The first term of this equation is the log-likelihood of the logit problem, and the other terms are constants. Thus, if the distributional assumptions are met the coefficient estimates will be the same in both models.

However, this model is unsuited for my data. Table 4.4 shows the means and variances of my establishments counts for each industrial sector, as well as the post-estimation goodness-of-fit test p-balues for the Deviance and Pearson goodness-of-fit tests[10]. As is plain from the table, the count data are not distributed poisson. Since the distributional assumptions are not met, poisson and conditional logit are not equivalent in this case.

[H]

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[10]For these statistical tests, a significant coefficient means to reject the null hypothesis that the data are distributed Poisson.

Table 4.4: Poisson Goodness of Fit Tests

	Mean	Variance	Deviance GOF	Pearson GOF
Agri., Fores., and Fish.	7.79	46.46	0.00	0.00
Mining, Util., and Constr.	55.88	4914.79	0.00	0.00
Manufacturing	21.23	499.57	0.00	0.00
Trade and Transport	156.40	42666.01	0.00	0.00
Professional Services	78.45	18783.35	0.00	0.00
Education and Health	31.33	1698.82	0.00	0.00
Other	70.36	10775.22	0.00	0.00

Notes: Table shows sample means and variances of the number of establishments picking each commuting zone by industrial sector. Columns 3 and 4 show p-values of the Deviance and Pearson Goodness-of-fit tests, respectively, for the Poisson distribution. A significant p-value indicates that the null hypothesis of the data being distributed Poisson should be rejected.

B   Adjustment for Establishment Observation

As discussed in Section 3, my unit of observation is an establishment rather than a firm. More precisely, I observe all of the branch offices in a particular municipality as a single line of data (hereafter "establishment"), and I cannot link establishments across municipalities. A simple application of Bayes rule shows how this could potentially bias my empirical result. In my data, a unit of observation is a new establishment that is observed in my dataset, where observed means that a new establishment that is not located in a municipality where the expanding firm is already operating. Therefore, my expression for the share of establishments in sector m picking a particular location C may be more precisely written as:

$$\text{share}_m(\text{pick C}|\text{observed in data}) \approx \text{pr}_m(\text{pick C}|\text{observed in data}) \tag{5}$$

Bayes' rule implies

$$\text{pr}_m(\text{pick C}|\text{observed in data}) = \frac{\text{pr}_m(\text{pick C})\text{pr}_m(\text{observed in data}|\text{pick C})}{\text{pr}_m(\text{observed in data})} \tag{6}$$

Combining the two expressions and taking the ratio of shares for a base location 0 as in the main analysis

$$\frac{\text{share}_m(\text{pick C}|\text{observed in data})}{\text{share}_m(\text{pick 0}|\text{observed in data})} \approx \frac{\text{pr}_m(\text{pick C})}{\text{pr}_m(\text{pick 0})} \frac{\text{pr}_m(\text{observed in data}|\text{pick C})}{\text{pr}_m(\text{observed in data}|\text{pick 0})} \tag{7}$$

The first term $\frac{\text{pr}_m(\text{pick C})}{\text{pr}_m(\text{pick 0})}$ leads to the same unconditional logit share ratio equation as in the main specification. The second term is what could potentially bias my results. After substituting my functional forms of the logit into the share ratio equation and taking logs, I obtain the following structural equation:

$$ln(\frac{s_{ctm}}{s_{0tm}}) = y_{ctm} - y_{0tm} + ln(\text{pr}_{mt}(\text{observed in data}|\text{pick C})) - ln(\text{pr}_{mt}(\text{observed in data}|\text{pick 0})) \tag{8}$$

In my reduced-form analysis, the term $ln(\text{pr}_{mt}(\text{observed in data}|\text{pick 0}))$ is cleanly captured by the time fixed effect, and the term $ln(\text{pr}_{mt}(\text{observed in data}|\text{pick C}))$ is at least partially absorbed by the location fixed effect. To bias the coefficients of interest spillovers or taxes would need to be correlated with $ln(\text{pr}_{mt}(\text{observed in data}|\text{pick C}))$, but not in a way correlated within commuting zone or year.

Of greater concern is the fact that I am using the location fixed effect in order to back out the sector-location productivity for my counterfactual exercises, the inability to observe the location choices of the universe of new establishments could affect these estimates. I cannot directly control for this since, as discussed, there is no way to calculate the probability of observing a new establishment in the data conditionally or unconditionally. In order to test whether this is a problem in practice, I repeat my main counterfactual exercises without including the location fixed effect when I back out my measure of productivity.

The results of this bounding exercise for the number of establishments are shown in Figure B.1. As is clear from the figure, the main results are similar whether or not I include

the location fixed effect in my measure of productivity, with the distribution being nearly identical with the exception of the right tail being shifted up slightly. As for within commuting zone, Panel B shows that for the majority of the commuting zones the predictions are strongly correlated.

For wages, things are slightly different, which can be seen in B.2. In particular, Panel A show that the distribution of wage effects is more negative in the bounding exercise. Furthermore, as seen in Panel B, the individual commuting zone predictions of wage effects are only weakly correlated when the fixed effect is excluded. Thus, the main results for wages should be thought of as an upper bound of the true effects on wages, with results for individual commuting zones being sensitive to its inclusion. In the main results, I choose to include the fixed effect because it includes factors other than the adjustment for establishment observation, such as natural advantage.

Figure B.1: Bounding Exercise: Adjustment for Establishment Observation and Establishment Counts
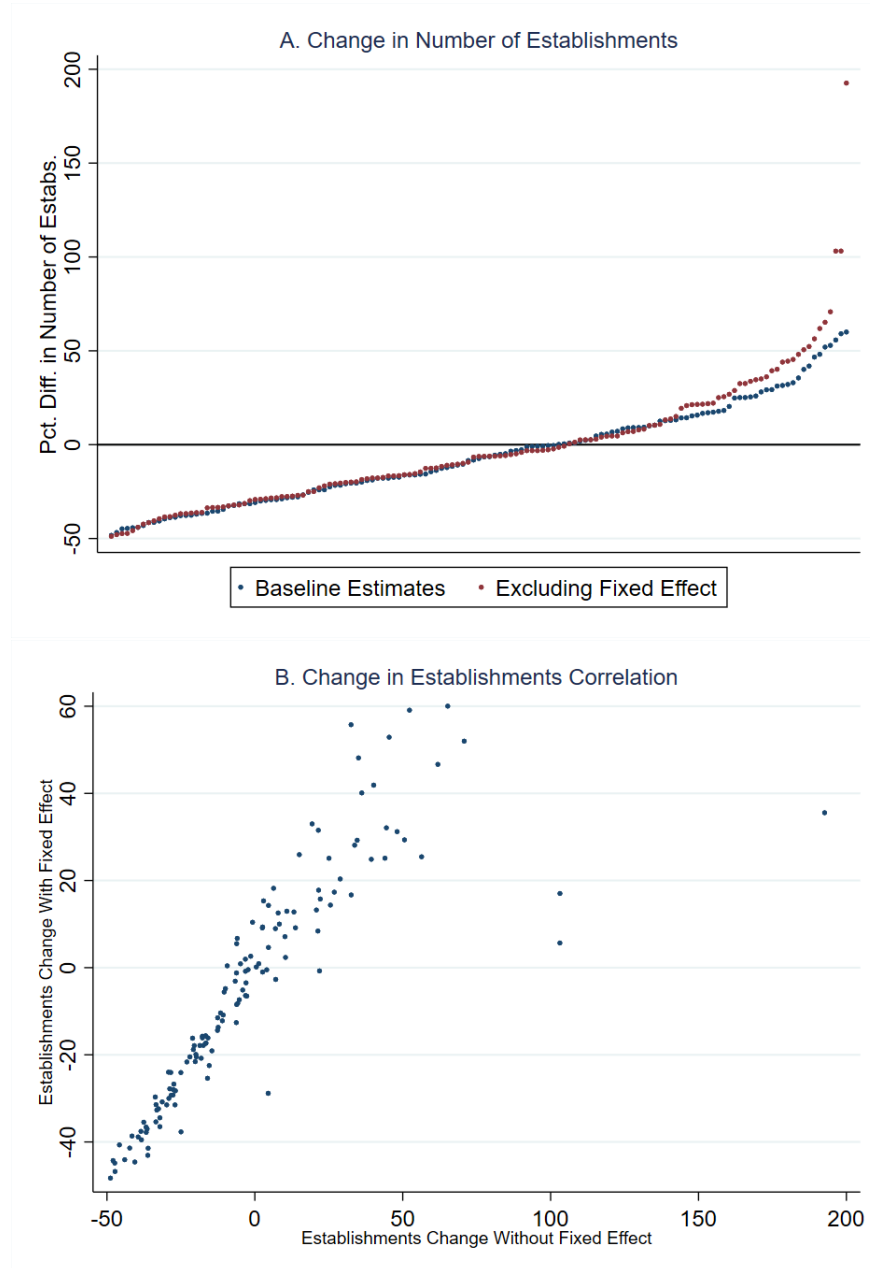
Notes: Each dot is a commuting zone. Panel A shows the percent difference in establishments in the year 2017 between the actual and counterfactual policy for both the baseline estimates and when the location fixed effect is excluded from the measure of β_{ctm}. Panel B shows the commuting-zone level correlation in the percent difference in establishments. See Section 5 for details on calculations on calculations of the counterfactual effects. The commuting zones with the lowest and highest change in number of establishments were trimmed.

Figure B.2: Bounding Exercise: Adjustment for Establishment Observation and Wages
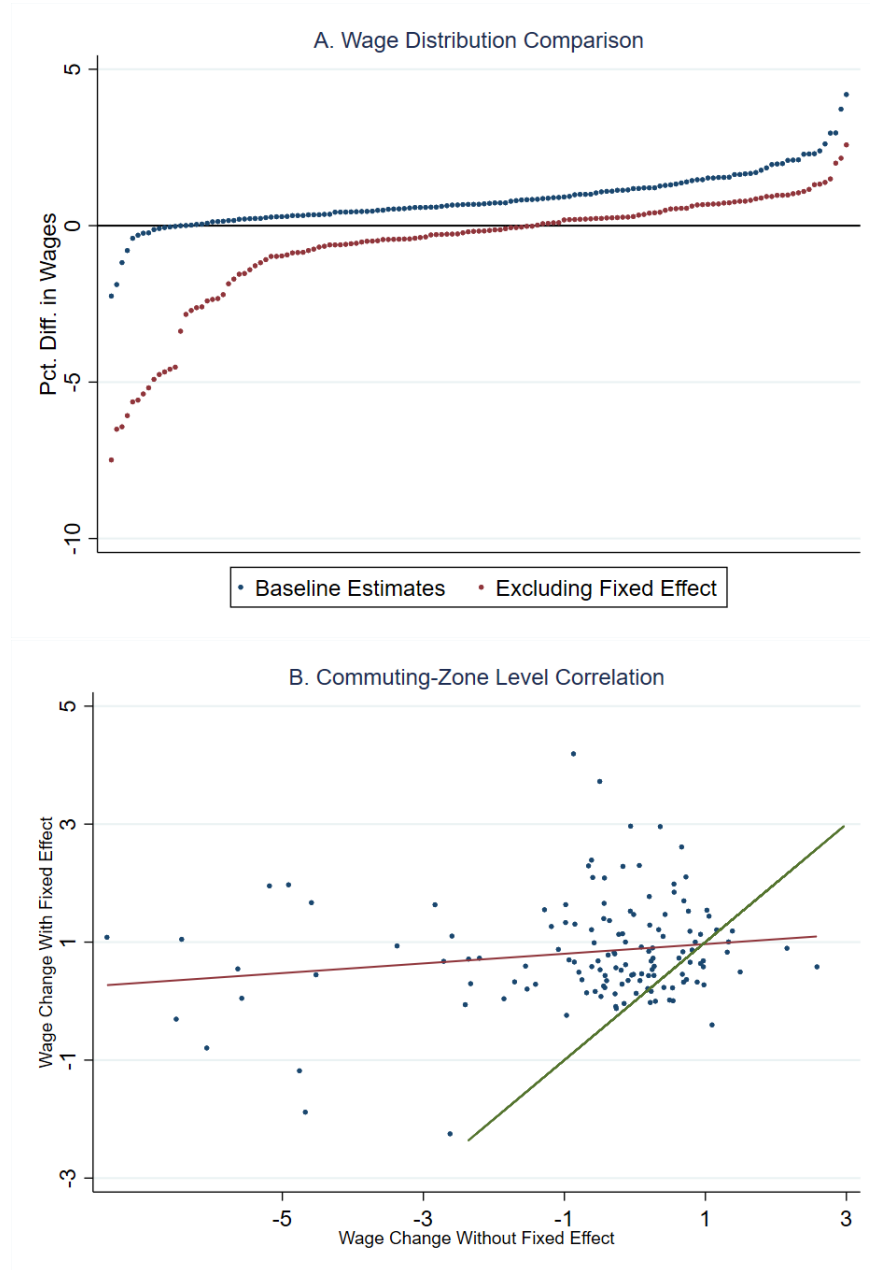
Notes: Each dot is a commuting zone. Panel A shows the percent difference in wages in the year 2017 between the actual and counterfactual policy for both the baseline estimates and when the location fixed effect is excluded from the measure of β_{ctm}. Panel B shows the commuting-zone level correlation in the percent difference in wages. See Section 5 for details on calculations on calculations of the counterfactual effects. The commuting zones with the lowest and highest change in number of establishments were trimmed.

C   Pre-estimation of μ_c and $\mathcal{L}_{ct}\lambda_{ct}$

C.1   Estimation of μ_c

I estimate the elasticity of labor supply to the firm using the method of Bassier et al. (2022). The estimating equation is a regression of an indicator for separating from an establishment:

$$s_{ijt} = \sum_j -(\frac{1}{2}\mu_c)\phi_j f_{jt}^i + X_{it} + v_{ijt}$$

Where s_{ijt} is an indicator for separation of individual i from establishment j at time t, ϕ_j is the AKM fixed effect of the establishment, and f_{jt}^i is an indicator variable for individual i working at establishment j in time t. Put simply. the coefficient of interest is on the AKM establishment effect. Figure C.1

C.2   Estimation of $\mathcal{L}_{ct}\lambda_{ct}$

With the estimate of μ_c in hand, I turn to estimation of the market size. Recall the labor supply equation of an establishment:

$$L_{ctj}(w_{ctj}) = \mathcal{L}_{ct}\lambda_{ct}exp(\mu_c ln(w_{ctj} - b_{ct}) + a_m) \tag{4}$$

In a log regression, with the pre-estimate of μ_c, the market size may be estimated using a simple fixed-effects regression:

$$ln(L_{ctm}(w_{ctm})) - \hat{\mu}_c ln(w_{ctj} - b_{ct}) = ln(\mathcal{L}_{ct}\lambda_{ct}) + a_m + \epsilon_{cjt} \tag{1}$$

D   Including Rental Prices

Rental prices are a key component of classic spatial equilibrium models. Since I make the assumption that workers are immobile, the inclusion of rental prices does not change the workers' labor supply decision since rental prices they pay do not differ no matter which firm they choose to work at in their commuting zone. However, rental prices will enter the establishment's profit equation. Assume that establishments pay a fixed price r_c per square meter of space they rent. Each worker requires a fixed amount of space k that does not differ between locations. This leads to the profit equation:

$$Y_{jc} = (1 - \tau_{ct})[\beta_{ctm}L_{ctm}(w_{cjt}) - L_{cjt}(w_{cjt})w_{cjt} - kr_c L_{ctm}(w_{cjt})] \tag{1}$$

Taking first order conditions leads to the wage equation:

$$w_{ctm} = \frac{\mu_c}{1 + \mu_c}(\beta_{ctm} - r_c k) + \frac{1}{1 + \mu_c}b_{ct} \tag{2}$$

This wage equation is very similar to the wage in the main specification, but the productivity portion of the wage is marked down by the price that the establishment needs to pay in rental

Figure C.1: Elasticity of Labor Supply Across Space
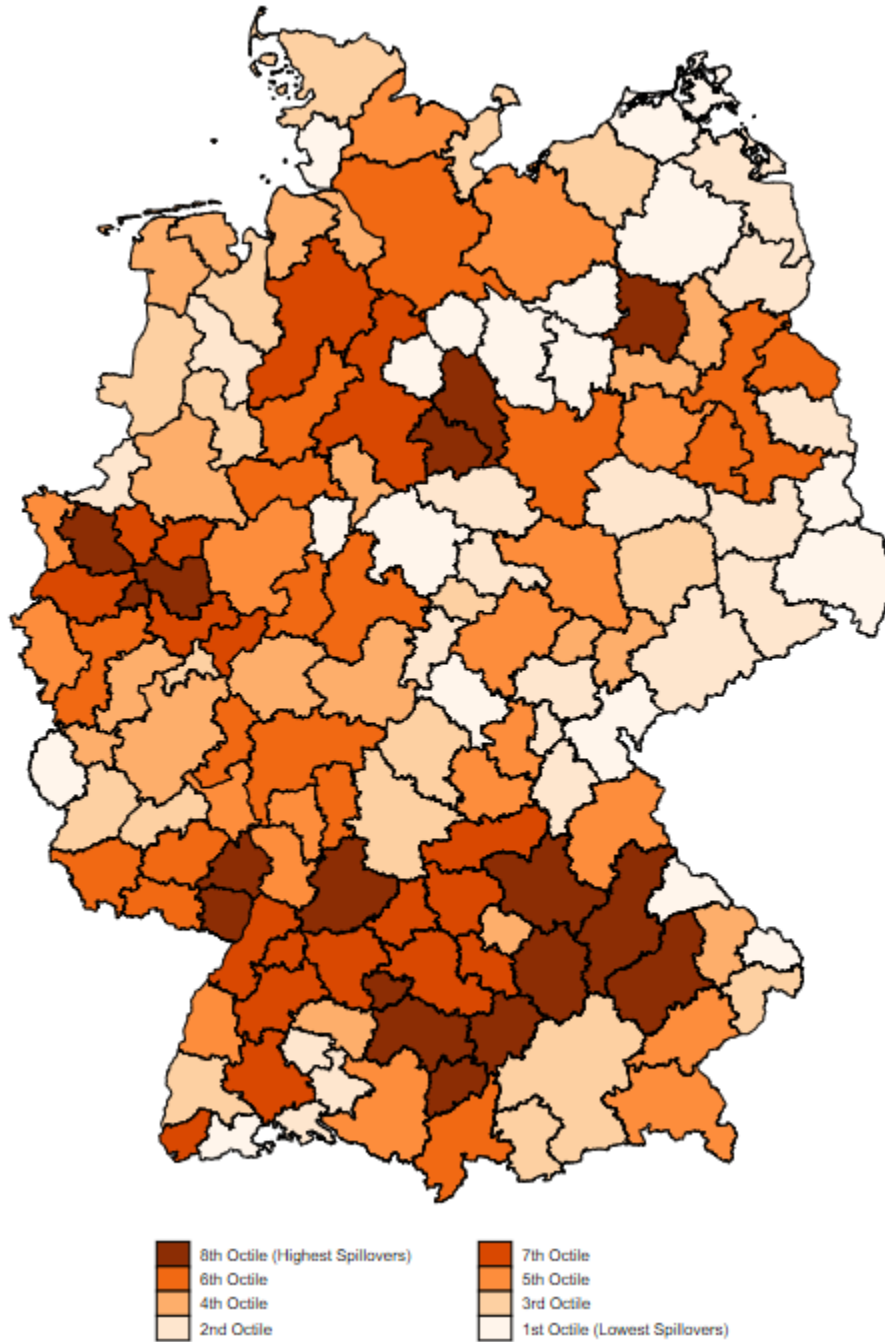
Notes: These figures show the octiles of point estimates of coefficients of the elasticity of labor supply for each commuting zone in Germany calculated using the method from Bassier et al. (2022).

prices. When functional forms are substituted back into the wage equation and I log-linearize, the log-profits are:

$$y_{cjt} = \mu_c ln(\mu_c) + ln(\mathcal{L}_{ct}\lambda_{ct}) + (1 + \mu_c)ln[\frac{1}{1 + \mu_c}(\beta_{ctm} - r_c k - b_{ct})] + ln(1 - \tau_{ct}) + u_{ctj} \quad (3)$$

The difference between this specification is that now rents appear in the productivity term of the equation. I can control for this directly in my reduced form with data on rental prices. I obtained data on rental prices for Germany from the RWI-GEO-REDX dataset maintained by RWI-Essen. Unfortunately, this data is only for residential housing prices rather than commercial real estate prices, but data on commercial prices is not available for Germany.

The dataset provides information on relative housing prices within each district (Klick and Schaffner, 2021). I combine the reported fixed effects from the first cross-sectional regression 2 and the housing price growth rates from regression 3 of their paper to create a panel dataset of relative housing prices over time which is merged with my main dataset. I report the results of the main regression specification controlling for rents in Appendix Table 3.3. As this data is only available from 2008 forward, so including it as a control necessitates cutting my panel in half. Therefore, I additionally report the results of the main specification without controlling for rents for the same set of years 2008 to 2017.

The coefficient estimates of interest are not significantly different when controlling for rental prices compared to not, and the only sectors with a significant coefficient on rental prices (mining utilities, and construction; trade and transportation; and education and health) are only weakly significant at the 10% level. This indicates that I should not be concerned about rental prices biasing my main results.

Table 3.3: Affect of Rental Prices

Panel A: Rental Price Controls

	Ag. For. Fish.	Mine., Util., Constr.	Manu.	Trade, Transport	Prof. Serv.	Edu., Health.	Other
Tax	8.698	7.431**	9.961**	0.593	4.302*	-0.394	7.662***
	(6.461)	(3.010)	(4.533)	(2.266)	(2.585)	(6.760)	(2.881)
Outside Option	-0.565	-0.244	-0.852	-1.184***	-0.500	0.162	-1.496***
	(0.948)	(0.489)	(0.671)	(0.328)	(0.476)	(0.921)	(0.442)
Input-Output	-1.970	-0.572	2.734	0.737	7.559**	-2.118	-0.201
	(1.989)	(1.270)	(2.151)	(0.815)	(3.472)	(2.258)	(1.849)
Labor Correlation	0.754	-45.38***	-16.80	27.73**	-2.841	-71.24**	11.99
	(8.176)	(10.85)	(26.62)	(13.09)	(10.41)	(34.65)	(9.381)
Knowledge	-0.00148	0.0527	0.0920*	-0.000959	0.0233	-0.0242	-0.0115
	(0.0902)	(0.0375)	(0.0479)	(0.0268)	(0.0318)	(0.0589)	(0.0383)
Rental Prices	0.00139	0.00363*	0.00442	0.00231*	0.00224	-0.00828*	0.00243
	(0.00371)	(0.00204)	(0.00338)	(0.00136)	(0.00204)	(0.00500)	(0.00184)
N	1345	1400	1380	1400	1397	1396	1400
F	6.599	53.54	35.73	86.57	80.81	13.92	56.98

Panel B: No Rental Price Controls

	Ag. For. Fish.	Mine., Util., Constr.	Manu.	Trade, Transport	Prof. Serv.	Edu., Health.	Other
Tax	9.254	8.513***	11.36**	1.251	5.065**	-2.045	8.583***
	(6.173)	(2.944)	(4.492)	(2.332)	(2.583)	(6.819)	(2.813)
Outside Option	-0.616	-0.280	-0.898	-1.250***	-0.537	0.300	-1.575***
	(0.980)	(0.498)	(0.667)	(0.332)	(0.498)	(0.911)	(0.442)
Input-Output	-1.899	-0.240	2.177	0.916	7.976**	-1.911	-0.548
	(2.007)	(1.254)	(1.991)	(0.832)	(3.270)	(2.134)	(1.876)
Labor Correlation	0.412	-46.24***	-16.40	27.86**	-3.481	-64.91**	12.18
	(8.000)	(11.02)	(26.23)	(13.20)	(10.65)	(31.02)	(9.431)
Knowledge	-0.00148	0.0522	0.0906*	-0.00141	0.0225	-0.0189	-0.0123
	(0.0903)	(0.0379)	(0.0472)	(0.0268)	(0.0319)	(0.0572)	(0.0384)
N	1345	1400	1380	1400	1397	1396	1400
F	7.640	68.61	41.19	96.83	78.63	18.88	70.70

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Results of the reduced-form specification in equation 10, also controlling for rental prices.

Notes: Results of the IV empirical specification equation (10) with spillover and outside option instruments constructed as shown in equation (13) with additional controls for residential rental prices within the commuting zone described in Klick and Schaffner (2021). Each column is an industrial sector. The outcome variable is the log ratio of the share of new establishments locating in a location c compared to a base location 0 (Hamburg) - $\mu_c \ln(\mu_c)$. Tax, outside option, and input-output spillovers are log transformations, while the labor correlation spillovers are an inverse hyperbolic since transformation. All regressions include commuting zone and year fixed effects as well as controls for the market size parameter pre-estimated as outlined in Appendix Section C, share highly/medium qualified workers, share women, share full-time workers, share prime aged workers, and share German workers. Standard errors are clustered at the commuting-zone level.

E   Incorporating Extensive Margin Effects

In the base specifications, there is no extensive margin. There is a pool of establishments that have decided to enter the market, and they are only choosing a location. Thus, the logit model is zero-sum. If an establishment chooses one location they are by definition taking possible economic activity away from other locations. In this model, place-based policies cannot do anything other than redistribute economic activity across space. This is a strong assumption, in reality there are likely establishments that could potentially enter the market given the right circumstances, but have chosen not to. Schmidheiny and Brülhart (2011) discuss the effects of the lack of extensive margin on predicted counterfactual effects, and show that elascities of substitution between locations implied by the poisson and conditional logit model are boundary conditions for applied research. As discussed in Appendix A poisson analysis is not appropriate for my context, so I need an alternative bounding exercise.

My method estimates the elasticities of substitution directly using methods from the industrial organization literature, which has a standard method of addressing this problem by imputing the potential market size and including the numeraire in the choice set of alternatives. In this section, I follow this approach and estimate the effects of incorporating the extensive margin by estimating the market share of the numeraire. To estimate potential market size, I calculate the ratio of establishments:residents for each commuting zone-sector-year cell. I then define the potential market size as the number of establishments that would exist if every commuting zone-sector-year cell had the number of establishments that would exist with the maximum ratio.

This should be thought of as an absolute upper bound of the potential extensive margin effects for two reasons. First, it is unlikely that every location could support the maximum ratio of establishments, particularly for every sector. As a simple example, it is highly unlikely that every location would be able to support the same number of mining establishments due to minerals not being evenly distributed across space.

Second, an individual location may exceed the maximum ratio in the counterfactual analysis since the potential market size is necessarily defined at the national level. Imposing bounds at the commuting-zone level is conceptually difficult. Since the number of residents is a parameter in the model it remains fixed in the model counterfactuals, but if a lot of economic activity was being attracted to a location it would probably attract some new residents as well. Estimating the scope of these effects is beyond the scope of this paper, but for these reasons the results shown below should be thought of as the upper bound.

Figure E.1 shows the estimated bounds on the percentage change in the number of establishments when extensive margin effects are incorporated. Panel A shows the distribution of the effects. As is clear from the figure, the prediction of the change is establishments is much more positive when extensive margin effects are incorporated, with the effect widening a the right tail of the distribution. Panel B shows the correlation between the individual commuting zone predictions with and without the extensive margin. The individual commuting zone predictions are highly correlated, though not perfectly. In sum, the predicted changes in the number of establishments is higher when extensive margin effects are incorporated, with fairly uniform predictions for all commuting zones.

Figure E.2 shows the estimated bounds on the percentage change in wages when extensive margin effects are incorporated. Overall, these effects are quite close to the distribution seen

in the main results. As shown in Panel A, the left tail of the wage distribution is lower in the specification incorporating extensive margin effects, but by the 40th percentile or so of the distribution the two are very close. The individual commuting-zone correlations in Panel B demonstrate that the wage predictions in the main results strongly predict the wage effects in the bounding exercise, with the slope being close to the 45 degree reference line.

Overall, the extensive margin effects probably mean that my baseline estimates of the effects of place-based policies are more negative than they would be in reality in terms of the number of establishments, particularly for already competitive areas, though how much more negative is dependent on how large the extensive margin is. I leave the question of the exact size of the extensive margin effects to future work.

Figure E.1: Bounding Exercise: Incorporating Extensive Margin Effects
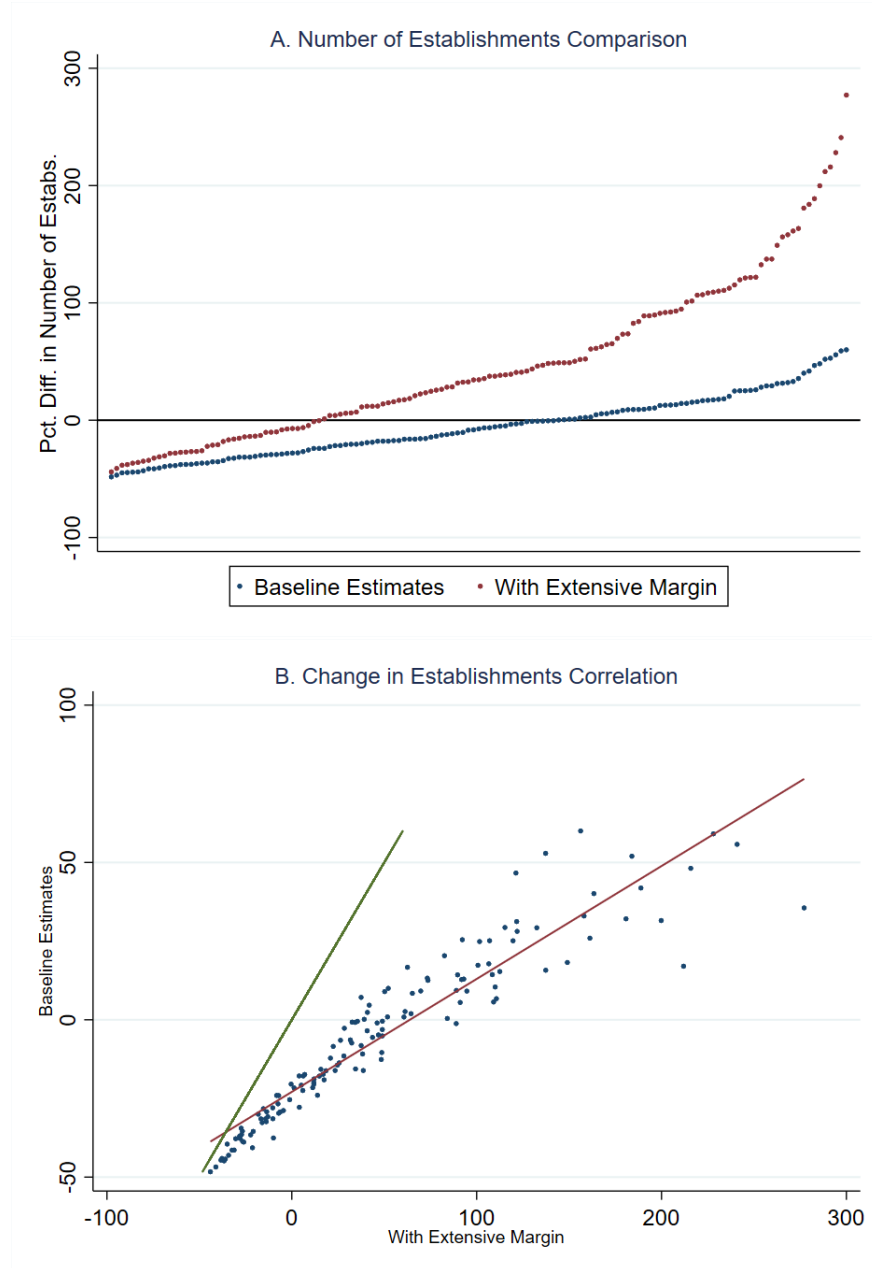
Notes: Each dot is a commuting zone. Panel A shows the percent difference in establishments in the year 2017 between the actual and counterfactual policy for both the baseline estimates and when the choice set includes the numeraire as described in Appendix Section E. Panel B shows the commuting-zone level correlation in the percent difference in establishments. See Section 5 for details on calculations of the counterfactual effects. The commuting zones with the lowest and highest change in number of establishments were trimmed.

Figure E.2: Bounding Exercise: Incorporating Extensive Margin Effects
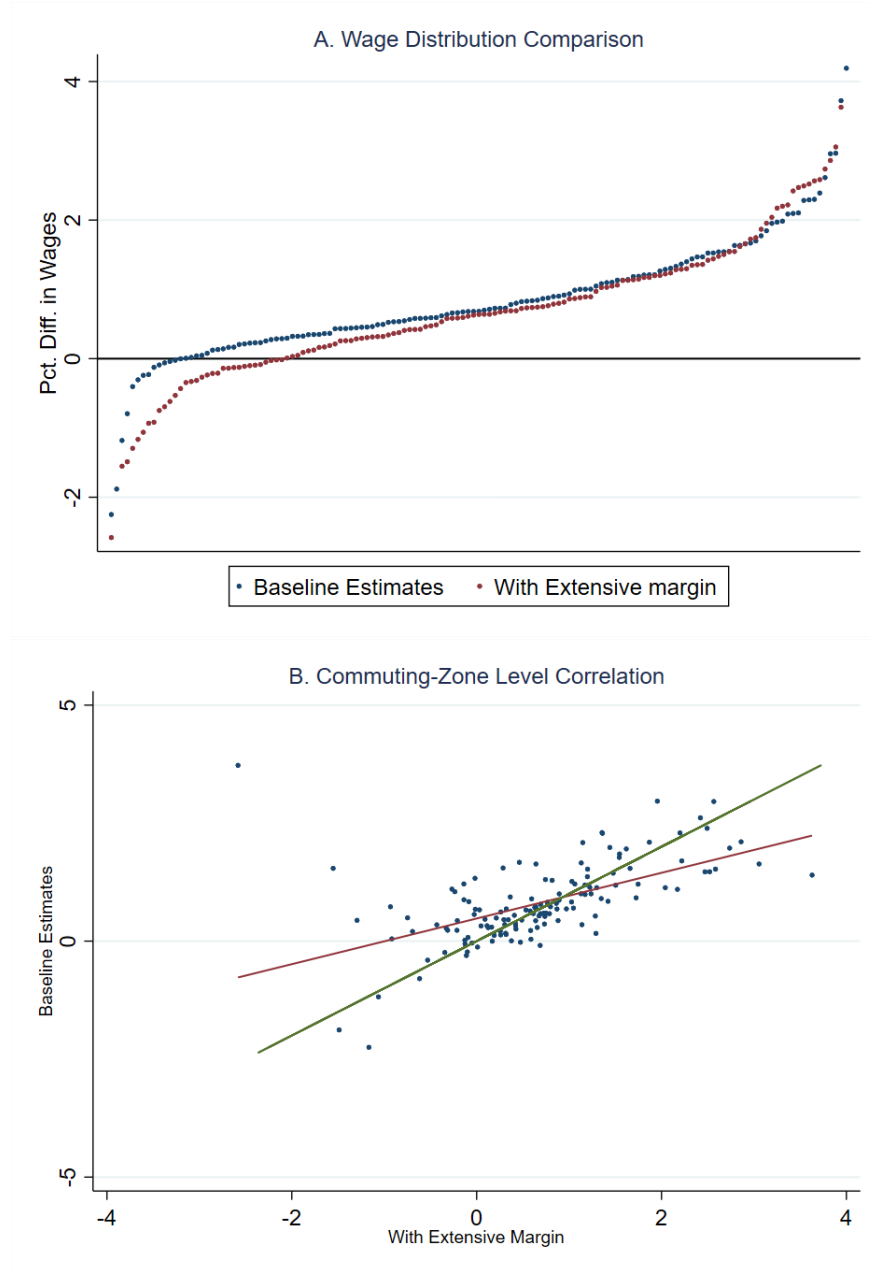
Notes: Each dot is a commuting zone. Panel A shows the percent difference in wages in the year 2017 between the actual and counterfactual policy for both the baseline estimates and when the choice set includes the numeraire as described in Appendix Section E. Panel B shows the commuting-zone level correlation in the percent difference in wages. See Section 5 for details on calculations of the counterfactual effects. The commuting zones with the lowest and highest change in number of establishments were trimmed.

F   Additional Results

Figure F.1: Coefficients by Sector - OLS
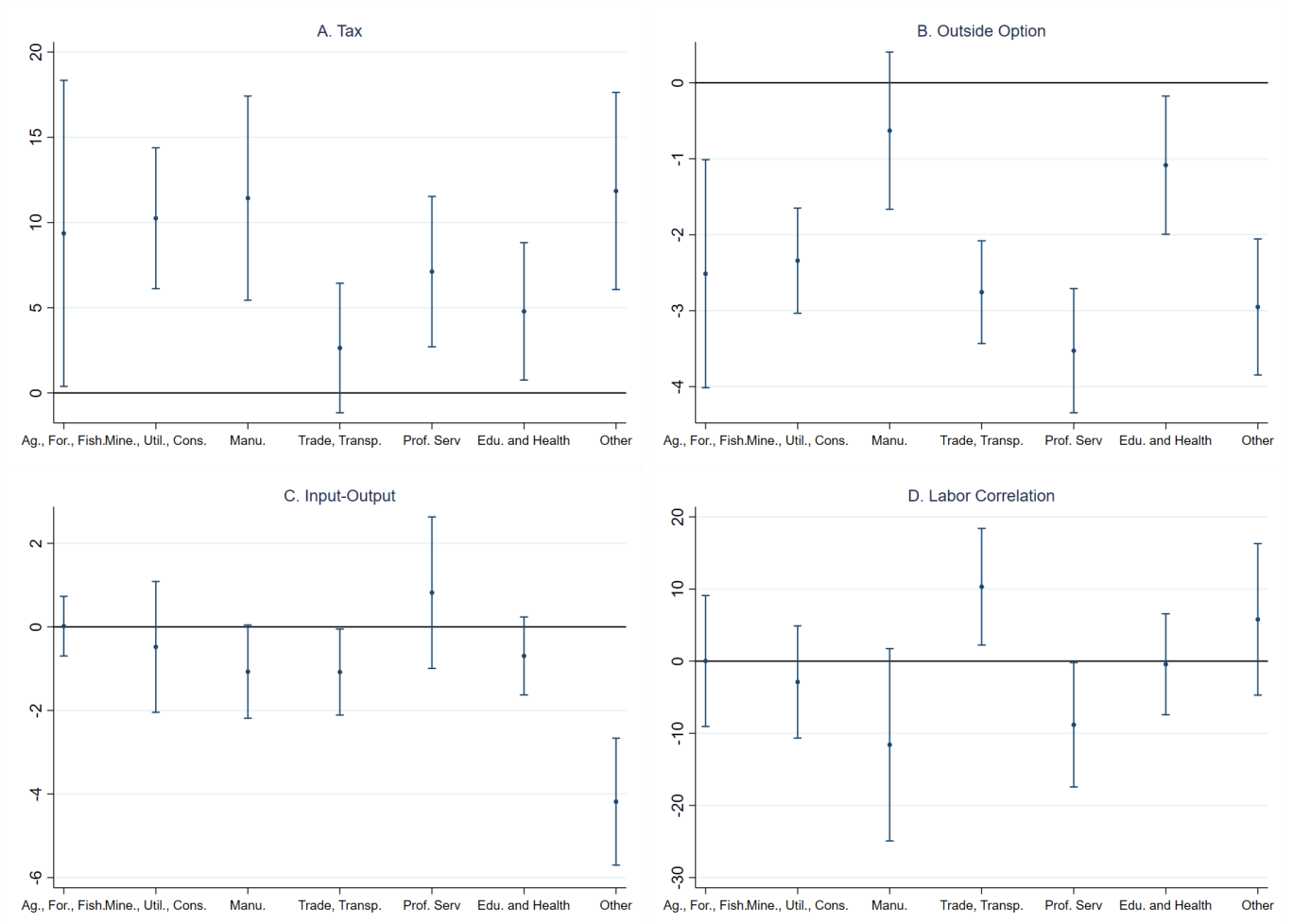
Notes: Results of the OLS empirical specification equation (10). Each column is an industrial sector. The outcome variable is the log ratio of the share of new establishments locating in a location c compared to a base location 0 (Hamburg) - $\mu_c \ln(\mu_c)$. Tax, outside option, and input-output spillovers are log transformations, while the labor correlation spillovers are an inverse hyperbolic since transformation. All regressions include commuting zone and year fixed effects as well as controls for the market size parameter pre-estimated as outlined in Appendix Section C, share highly/medium qualified workers, share women, share full-time workers, share prime aged workers, and share German workers. Standard errors are clustered at the commuting-zone level. See section 3 for details on the construction of the variables of interest.