

DISCUSSION PAPER SERIES

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## ABSTRACT

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### Labor Market Concentration in Germany\*

Using register data, we document that the average German labor market, defined by hires in combinations of 3-digit occupations, requirement levels, and commuting zones, is highly concentrated ( $HHI=0.257$ ). By EU antitrust thresholds, 56 percent of these labor markets feature moderate or high concentration, covering 9 percent of workers. Concentration remained relatively stable between 2012 and 2023. The labor market delineation strongly affects the measured level of concentration but not its evolution, whereas the choice of the firm size variable has little influence. Concentration differs starkly across occupations and regions, and workers in complex jobs experience the highest levels of concentration.

**JEL Classification:** J42, L10, J60

**Keywords:** labor market concentration, monopsony power, occupations

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## 1 Introduction

The employer’s market (or monopsony) power is the focus of many recent studies because it determines labor market outcomes as well as the effects of policy intervention. To measure monopsony power, many papers rely on labor market concentration, which can be justified using oligopsony-style models (Robinson, 1933; Boal and Ransom, 1997; Berger, Herkenhoff, and Mongey, 2022) as well as search models with multi-vacancy firms (Jarosch, Nimczik, and Sorkin, 2024). In line with predictions from such models, the literature shows that higher labor market concentration reduces wages (Azar, Marinescu, and Steinbaum, 2022; Benmelech, Bergman, and Kim, 2022; Schubert, Stansbury, and Taska, 2022; Dodini et al., 2024), affects wage inequality (Rinz, 2022; Mertens, 2023), increases employment insecurity (Bassanini et al., 2024), and worsens other working conditions (Adams-Prassl et al., 2023; Qiu and Sojourner, 2023; Anderlik et al., 2024). Labor market concentration moderates the effects of minimum wages (Azar et al., 2024; Popp, 2024) on workers’ outcomes, and its changes determine the wage growth effects of firm mergers (Prager and Schmitt, 2021). Given these findings, it is not surprising that labor market concentration has become a prominent measure of employers’ market power.

Once we accept labor market concentration as a measure of monopsony power, it is natural to ask about the extent of labor market concentration. The OECD Employment Outlook 2022 (Araki et al., 2022) shows that high labor market concentration is relevant across all included countries, but varies substantially. The share of workers in moderately and highly concentrated labor markets ranges from less than 8 percent of workers in Belgium to more than 25 percent in Estonia. These stark differences between countries suggest that labor market concentration is a nuanced phenomenon calling for in-depth analyses also within countries. Several studies document wide variation in labor market concentration across regions and economic activities within the U.S. (Azar et al., 2020; Azar, Marinescu, and Steinbaum, 2022; Handwerker and Dey, 2024). Such detailed analyses are however not available for other countries. To start filling this gap, this paper documents labor market concentration in Germany.

Using the most comprehensive data on the German labor market, we provide a detailed account of labor market concentration in Germany. As calculating concentration measures requires delineating labor markets by economic activity and region, we first analyze the self-containment of markets for different such delineations. We then compare the measured labor market concentration when using different market delineations, measures of firms’ size, and concentration indices. Next, we explore systematic differences in concentration across labor markets. Finally, we switch to a worker-level perspective and document the fraction of workers



in concentrated labor markets and differences by workers' socio-demographic characteristics.

Our study thereby makes three contributions to the literature on the extent of labor market concentration. First, we provide systematic evidence on the self-containment of labor markets by comparing different market delineations. Specifically, we present self-containment using either occupation or industry—both at various levels of aggregation—to delineate economic activities which we combine with different spatial delineations. Our results help guide us (and hopefully other researchers) in choosing what constitutes a labor market. Second, we contrast the extent of labor market concentration and its evolution over time when varying how to measure it. The results foster assessing the consequences of how we measure labor market concentration, which in practice is often at least partly determined by the availability of data. Third, we provide the first detailed analysis of concentration of occupational labor markets in Germany. Specifically, we scrutinize the key explanatory forces that contribute to the prevalence of concentrated labor markets and study which socio-demographic groups are least and most affected by labor market concentration. This complements the currently available evidence on Germany by Popp (2024), who focuses on labor markets defined by industry, and Bassanini et al. (2024), who focus on an international comparison across European countries and hence can provide limited evidence on each country.

Our analysis yields the following eight insights. First, workers are more attached—as measured by self-containment rates—to the spatial than to the economic dimension of the labor market. Second, self-containment is somewhat higher when relying on occupations than on industries. Third, the average labor market in Germany—delineated by 3-digit occupation, requirement level, and commuting zone as our baseline—features an Herfindahl-Hirschman Index (HHI) of 0.257, and over half of the labor markets are moderately or highly concentrated according to thresholds in the EU merger guidelines. Fourth, the choice of the firm size variable influences the measured labor market concentration less than the choice of the market definition. Fifth, regardless of the labor market definition, average concentration remained relatively stable between 2012 and 2023. Sixth, concentration differs starkly across occupations and regions, with HHI levels being positively correlated with the share of manual routine tasks and negatively correlated with local population. Seventh, larger labor markets are on average less concentrated which is why the share of moderate or high concentration drops to 8.7 percent when switching from the market to the worker level. Eighth, concentration is higher for workers in complex jobs, male workers, regular full-time workers, and workers in East Germany, whereas it does not differ by worker's nationality.

## 2 Defining Labor Market Concentration

Measuring labor market concentration requires a labor market delineation, a measure of employers' size, and an index of concentration. This section briefly sketches each of these three aspects.

### 2.1 Delineating Labor Markets

Measuring concentration requires a definition of the relevant labor market, which should ideally comprise all relevant job opportunities of workers in this market. The literature typically defines labor markets as two-dimensional combinations of economic activity and space, but so far no consensus has emerged on how to operationalize both (see the examples in Manning, 2021).

The two main approaches to operationalize economic activity are industries (e.g., used by Berger, Herkenhoff, and Mongey, 2022; Benmelech, Bergman, and Kim, 2022; Rinz, 2022) and occupations (e.g., used by Azar et al., 2020; Marinescu, Ouss, and Pape, 2021; Azar, Marinescu, and Steinbaum, 2022). One reason for preferring occupation-based definitions is that industry-based measures may conflate labor market and product market competition even though both do not necessarily coincide (e.g., Manning, 2021; Araki et al., 2022). That said, industry-based definition may still be preferable for substantive reasons (e.g., for evaluations of specific industry-specific policies) or when analyzing the effects of concentration at the level of firms. Occupations and industries are typically defined and grouped according to administrative classifications.<sup>1</sup> Classifications are available at various levels ranging from broad occupational or industrial categories at the 1-digit level to fine-grained categories at the 5- or even 6-digit level.

Regarding space, most studies rely on commuting zones, acknowledging that commuting flows cross administrative borders. However, commuting zones are not beyond doubt for three reasons. First, even a commuting zone that perfectly describes the labor market of a worker sitting in its center will not adequately capture the labor market from the perspective of a worker sitting close to its border due to the fixed, non-overlapping definition of commuting zones. Second, the relevant labor market will be smaller than the commuting zone in many cases (Manning and Petrongolo, 2017) and thus commuting zones will regularly include workplaces that workers are extremely unlikely to choose. Third, commuting zones are often constructed differently across countries hampering international comparisons.

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<sup>1</sup>Dodini et al. (2024) are an exception as they cluster occupations by their task content into groups and thereby form groups by economic activity that rely less on administrative definitions.

Therefore some studies rely on administrative regions or combinations of functional and administrative regions (e.g., Araki et al., 2022; Bassanini et al., 2024). Similar to categories of economic activities, space can furthermore be defined at widely different levels. When relying on administrative delineations, the possible level of aggregation ranges from federal states (NUTS-1) to municipalities (LAU) or even neighborhoods.

Definitions of labor markets that aim to comprise all relevant job opportunities face a trade-off between making labor markets narrow to exclude irrelevant jobs and making them broad to include all relevant outside options to obtain self-contained markets. For any but the broadest definition, markets will not be self-contained as some workers will move across markets. To assess how well different delineations of labor markets perform in this dimension, Section 4 compares the self-containment of labor markets defined by occupation or industry times region using different levels of aggregation for economic activity and space. Based on this comparison, our baseline definition of a labor market when measuring concentration will be by (relatively detailed) occupation times commuting zone.

## 2.2 Measuring Employers' Size and Market Share

The literature on labor market concentration is inconclusive when it comes to the choice of the object (or share) variable to measure employers' size and market share. Typical measures are based on employment stocks, on hirings or vacancies, and on the wage bill. In practice, the choice of a measure of firms' size is often dictated by the available information.

Measuring firms' size based on employment can be justified on the grounds of the Cournot oligopsony model (Boal and Ransom, 1997), in which the average markdown is a function of the employment-based concentration in the labor market (e.g., Benmelech, Bergman, and Kim, 2022; Qiu and Sojourner, 2023; Dodini et al., 2024). Furthermore, Jarosch, Nimczik, and Sorkin (2024) derive an employment-based measure of concentration from a search model with a finite number of employers that can commit to withhold job offers in the future if applicants decline a job offer today.

Measuring firms' size based on hires or vacancies has some intuitive appeal. It treats firms that do not intend to hire—e.g., because they are shrinking due to declining demand for their products—as offering no outside options for workers despite having a positive employment share. Focusing on hires assigns these firms a market share of zero (e.g., Marinescu, Ouss, and Pape, 2021; Bassanini et al., 2024). That said, one could argue that at least some of these firms are in principle willing to hire workers. Perhaps a complete exclusion is thus overly strict, but it is still likely to provide a more accurate reflection of the relevant outside options

than including all firms, regardless of their hiring activity.

Vacancies additionally include recruitment failures, which may give a more complete picture of firms' demand for recruits and thus workers' outside options (e.g., Azar, Marinescu, and Steinbaum, 2022; Schubert, Stansbury, and Taska, 2022). However, comprehensive micro-level data on vacancies is less readily available than data on hires.

Measuring firms' size based on the wage bill emerges from the oligopsony model with job differentiation in Berger, Herkenhoff, and Mongey (2022). In this model, markdowns increase in wage bill concentration. Wage bill concentration differs from employment concentration because larger employers pay higher wages, as has long been established (Brown and Medoff, 1989).

Following most of the literature, we will use hires as our baseline measure of firms' size. As our data also includes employment stocks and allows us to calculate wage bills, we will additionally provide results using these measures.<sup>2</sup>

### 2.3 Aggregating into a Concentration Measure

Following Marfels (1971), measures of absolute market concentration describe how a certain measure of firm size is distributed over firms. The HHI (Hirschman, 1945; Herfindahl, 1950) is the most common measure of market concentration in the literature. The HHI equals the sum of squared market shares

$$HHI_{mt} = \sum_{j=1}^J s_{jmt}^2 \quad (1)$$

where  $s_{jmt} = \frac{X_{jmt}}{\sum_{j=1}^J X_{jmt}}$  is the share of firm  $j$  according to firm size measure  $X$  in market  $m$  in year  $t$ . The inverse HHI gives the equivalent number of firms, which represents the number of equally-sized firm that would result in the same HHI value.

Abel, Tenreyro, and Thwaites (2020) show that calculating the HHI from a random sample of workers results in an upward bias. The HHI should hence ideally be calculated from the (almost) full population. This typically means using administrative data as in our study. Alternative data sources should include a dominant share of the market.

The continuum of possible HHI values spans from 0 to 1. Whereas an HHI value of 0 implies a perfectly atomistic market, an HHI value of 1 represents a market with a single employer. In many jurisdictions, the HHI constitutes a guideline for antitrust policy. The EU Commission (2004) evaluates the intensity of product market competition using three domains for HHI values: low (0.0-0.1), moderate (0.1-0.2), and high levels of concentration

<sup>2</sup>Unfortunately, we cannot reliably calculate measures of vacancy concentration because micro-level data on the (near-)universe of vacancies are not available for the German labor market.

(0.2-1.0). In the U.S., similar thresholds have been legislated and, since recently, additionally refer to labor markets (Federal Trade Commission, 2023). Against this backdrop, we will later use the EU antitrust thresholds for product markets to differentiate between labor markets with low, moderate, and high concentration.

The HHI combines the two dimensions of absolute concentration indices, namely the fewness of employers and the unevenness of their size. Adelman (1969) shows that the HHI can be reformulated as a function of the number of firms  $J$  (i.e., the fewness dimension) and the variance of market shares  $\sigma^2$  (i.e., the unevenness dimension):  $HHI = J\sigma^2 + \frac{1}{J}$ .<sup>3</sup> Two alternative concentration indices assign extreme weights to both dimensions. On the one hand, the so-called “Inverse Number of Firms”,  $\frac{1}{J}$ , purely reflects the fewness dimension.<sup>4</sup> This measure is often used to construct leave-one-out instrumental variables for labor market concentration (e.g., Azar, Marinescu, and Steinbaum, 2022; Bassanini et al., 2024). On the other hand, the sum of the  $n$  largest firms’ market shares,  $\sum_{j=1}^n s_{jmt}$ , mainly speaks to the unevenness dimension. A prominent example is the “3-Firm Concentration Ratio” which is the sum of shares of the three largest firms:  $\sum_{j=1}^3 s_{jmt}$ . As concentration ratios do not require information on the universe of firms, they are easier to obtain and thus are frequently used by antitrust authorities (e.g., German Monopolies Commission, 2024). Under German law (see Competition Act, Section 18), firms with a market share of at least 40 percent are deemed to hold a dominant market position. This threshold value increases to 50 percent for three firms and two thirds for five firms.

In Section 5, we will rely on the HHI as our index of concentration. To shed some light on the relative importance of the fewness and the unevenness dimension, we also report the inverse number of firms as well as the 1-, 3-, and 5-firm concentration ratios.

### 3 Data and Sample Definition

In this study, we leverage records from the German social security register, which forms the most comprehensive database on the German labor market, covering nearly the entire population of workers. Specifically, we use the Employment Histories (BEH) to calculate labor market concentration (IAB, 2024). The BEH data are a key source underlying the Integrated Employment Biographies (IEB) from the Institute of Employment Research (IAB) (Müller and Wolter, 2020). The BEH assembles notifications on all jobs in Germany that are subject to social security contributions. Consequently, the BEH data include all workers except civil

<sup>3</sup>Ahern, Kong, and Yan (2024) provide a detailed examination of the fewness and the unevenness dimension.

<sup>4</sup>If employers have equal size (i.e.,  $\sigma^2 = 0$ ), the HHI simplifies to  $\frac{1}{J}$ .

servants, self-employed persons, and family workers.<sup>5</sup>

Workers' biographies are provided as spell data on a calendar-year basis and contain information on start and end date of the job, type of contract, occupation, place of work, earnings (top-coded), industry, socio-demographic characteristics, and an establishment identifier, which we use as firm identifier as explained below. In general, BEH information is available from 1975 (West Germany) and 1993 (East Germany) onward. In 2011, the 3-digit German Classification of Occupation from 1988 (KldB-1988) was replaced by the new 5-digit classification from 2010 (KldB-2010). To avoid this structural break, we narrow our analysis to the years 2012–2023.

The KldB-2010 occupation variable in the BEH differentiates between 1,300 5-digit occupations (Bundesagentur für Arbeit, 2011).<sup>6</sup> The leading four digits define 702 occupational sub-groups, and the fifth digit distinguishes four requirement levels: jobs for helpers, professionals, specialists, or experts.<sup>7</sup> As the four requirement levels plausibly form segregated labor markets, we interact them with 1-digit, 2-digit, 3-digit, and 4-digit occupations which yields 39 detailed occupational areas, 135 detailed occupational main groups, 436 detailed occupational groups, and 1,300 detailed occupational sub-groups. Throughout the paper, we will use the term “detailed 1-digit occupations” etc. to highlight that we interact occupations with requirement levels.

The WZ-2008 industry variable in the BEH differentiates between 38 industrial sections (1-digit), 88 industrial divisions (2-digit), 272 industrial groups (3-digit), 615 industrial classes (4-digit), and 839 industrial sub-classes (5-digit). The leading four digits of the WZ-2008 classification coincide with the Statistical Classification of Economic Activities in the European Community (NACE Rev. 2).

Information on the workplace is available at the level of 10,785 municipalities, which is the German equivalent of the EU definition for local administrative units (“LAU”).<sup>8</sup> These municipalities belong to 16 federal states (NUTS-1 regions), 38 government regions (NUTS-2 regions), and 400 districts (NUTS-3 regions), with these levels being nested. As administrative regions may not necessarily capture the spatial dimension of labor markets, we additionally use functional regions that are designed with the objective of ensuring a high proportion of flows within these regions. Specifically, we draw on the aggregation of districts into 141

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<sup>5</sup>The data used in this project can be accessed for replication purposes according to the IAB's guidelines, see <https://iab.de/en/facts-and-figures-2/data-access-for-replication-purposes/>.

<sup>6</sup>We use the most recent version of the KldB-2010 Classification, which was updated in 2020.

<sup>7</sup>Helper jobs require no training or only a maximum of one year's training. Jobs for professionals include activities with industrial, commercial, or other vocational training. While jobs for specialists presuppose a bachelor or master craftsman degree, jobs for experts necessitate a master degree or an equivalent diploma. For most occupational sub-groups only some requirement levels are relevant.

<sup>8</sup>Our regional information always refers to territorial boundaries as of 31 December, 2023.

commuting zones by Kosfeld and Werner (2012), which may cross the borders of government regions and federal states. In Figure 1, we show a map to visualize the mapping of the 400 districts into 141 commuting zones (see Appendix Figure A1 for a version including the names of all commuting zones).

The establishment identifier refers to a regionally and economically delimited place of production where employees work. In principle, branch offices of one company that belong to the same industry and municipality are assigned a joint establishment identifier, whereas branches of the same company in different municipalities are assigned separate establishment identifiers. The establishment identifier hence acts as a company-by-municipality identifier, which we refer to as a firm identifier.<sup>9</sup>

To the extent that companies own establishments in different municipalities within the same labor market, we mistakenly treat them as separate entities, thereby leading to an underestimation of labor market concentration. However, we consider it unlikely that this data limitation materially affects our results for two reasons. First, the IAB Establishment Panel shows that, as of 2023, 85.4% of firms operate as single-establishment companies (Bellmann et al., 2024). Second, Bassanini et al. (2024) demonstrate that using firm identifiers rather than firm-by-municipality identifiers does not significantly alter concentration measures or regression results for Denmark, France, Italy, Portugal, and Spain. Given these two pieces of evidence, we might underestimate labor market concentration somewhat, though substantial distortions appear unlikely.

Those workers who are missing in the admin data, namely civil servants, family workers, and self-employed, are unevenly distributed across economic areas. To rule out any biases from this non-coverage, we restrict the sample to private-sector occupations. We do so by disregarding military occupations and those occupations whose underlying share of workers in the non-agricultural private business sector is lower than 50 percent in the BEH over the years 2012–2023.<sup>10</sup> The implementation of this heuristic reduces the number of detailed 3-digit occupations from 436 to 355 (see Appendix Table A1).

When preparing the data, we follow standard practice and distribute special payments proportionally among all other employment notifications of a worker in the same firm in the respective year. The information on earnings in the BEH is top-coded at the upper-earnings limit on social security contributions, which affects roughly 10 percent of regular full-time jobs. To address the top coding, we make use of imputed values from a two-step

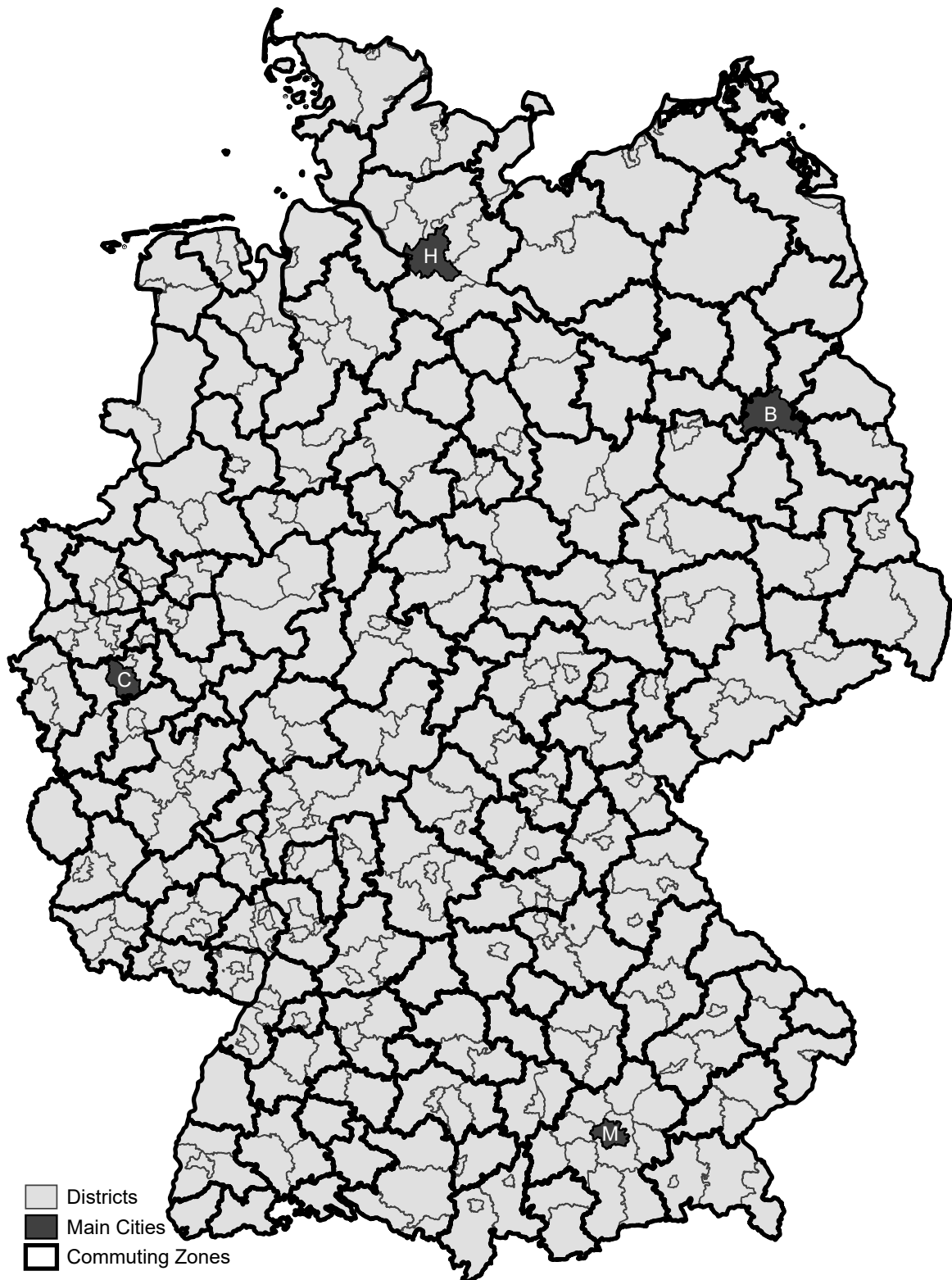
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<sup>9</sup>Throughout this paper, we use the term “company” when referring to all establishments from the same employer. There is no information regarding which firms are part of the same company.

<sup>10</sup>We define the non-agricultural private business sector in terms of the following 2-digit NACE Rev. 2 codes: 05-82, 90, 92-96.



Figure 1: Districts and Commuting Zones



NOTE. — The figure illustrates the delineation of 400 German districts (NUTS-3 regions) into 141 commuting zones. Cities with more than 1 million inhabitants are marked with capital letters: B = Berlin. C = Cologne. H = Hamburg. M = Munich. Source: Kosfeld and Werner (2012).



Tobit procedure from Drechsler, Ludsteck, and Moczall (2023).<sup>11</sup>

To circumvent multiple counting of jobs, we select the most important job for each worker-by-firm-by-year combination.<sup>12</sup> Moreover, we generally disregard jobs with a duration of less than 30 days to rule out that our concentration measures are driven by the availability of short-term jobs. We define a new hire as a worker who is employed in a firm in a certain calendar year, but was not employed in the same firm in the calendar year before.<sup>13</sup>

#### 4 Results on Self-Containment of Labor Markets

As defining labor market is the first step to measure concentration, we start by examining the self-containment of labor markets when using different delineations. To measure self-containment, we calculate the probability that a worker in a certain labor market and year was already employed in the very same labor market in the year before. We do this for all workers employed in that market, which is closer to an employment-based HHI, as well as for newly hired workers, which is closer to an hiring-based HHI.

Table 1 presents the self-containment of labor markets defined by region and occupation. Occupations are rather stable in the stock of employees with staying probabilities ranging from 90.1 percent for 39 detailed 1-digit occupations to 87.8 percent for 1,300 detailed 4-digit occupations. Focusing on newly hired workers reduces these self-containment rates to 45.8 and 34.3 percent, respectively. Self-containment rates are remarkably similar, implying that occupational transitions often occur between occupations that are not grouped together in the administrative classification.

Regarding regions, staying probabilities among all workers lie between 96.8 for 16 federal states and 89.3 percent for 10,785 municipalities. For new hires, the share ranges from 79.5 to 34.0 percent. In particular for new hires, self-containment falls sharply when using regional units smaller than commuting zones.

Comparing the self-containment across the two dimensions points towards a stronger

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<sup>11</sup>In a first step, the authors run Tobit regressions to generate leave-one-out averages of fitted wages per worker, per firm, and per occupation (each excluding the observation at hand). In a second step, the authors determine final values by repeating the Tobit regressions with the worker-, firm-, and occupation-specific leave-one-out averages as additional covariates. Specifically, the authors regress log daily censored wages of regular full-time workers on age, age squared, nationality, various tenure variables, various spell length variables, and the leave-one-out averages. Separate Tobit models are estimated for combinations of year, gender (2 groups), education (3 groups), age (4 groups), and East/West Germany (2 groups).

<sup>12</sup>To identify the most important job, we use a three-step procedure. First, we select spells for non-marginal employment over spells for marginal employment. Second, we select the spell with the highest daily wage. Third, when there is a tie, we select the spell with the longest duration.

<sup>13</sup>As our definition of hires is based on a worker's most important employment relationship in a given year, short-term layoffs followed by quick rehires are not considered as hires. We regard such patterns as potentially reflecting labor market concentration (and broader market power), rather than structural features of the labor market. Exploring how market power shapes rehiring patterns is beyond the scope of this paper.

Table 1: Self-Containment of Labor Markets Defined By Occupations

Spatial Delineation	None	16 Federal States NUTS-1	38 Government Regions NUTS-2	141 Commuting Zones	400 Districts NUTS-3	10,785 Municipalities LAU
Occupational Delineation						
<b>None</b>	100.0 (100.0) [1]	96.8 (79.5) [16]	95.4 (70.6) [38]	94.1 (63.1) [141]	91.5 (47.3) [400]	89.3 (34.0) [10,785]
<b>39 Detailed</b>						
<b>Occupational Areas</b>	90.1 (45.8) [39]	88.7 (37.5) [624]	88.0 (33.7) [1,482]	87.5 (30.3) [5,499]	86.3 (23.6) [15,600]	85.2 (17.6) [420,615]
1-Digit KldB-10 × Level						
<b>135 Detailed</b>						
<b>Occupational Main Groups</b>	89.0 (39.9) [135]	87.8 (32.8) [2,160]	87.2 (29.5) [5,130]	86.7 (26.6) [19,035]	85.7 (20.9) [54,000]	84.8 (15.9) [1,455,975]
2-Digit KldB-10 × Level						
<b>436 Detailed</b>						
<b>Occupational Groups</b>	88.3 (36.7) [436]	87.2 (30.2) [6,976]	86.7 (27.2) [16,568]	86.3 (24.6) [61,476]	85.3 (19.4) [174,400]	84.5 (14.8) [4,702,260]
3-Digit KldB-10 × Level						
<b>1,300 Detailed</b>						
<b>Occupational Sub-Groups</b>	87.8 (34.3) [1,300]	86.8 (28.3) [20,800]	86.3 (25.6) [49,400]	85.9 (23.2) [183,300]	85.1 (18.4) [520,000]	84.3 (14.2) [14,020,500]
4-Digit KldB-10 × Level						

NOTE. — The table displays the self-containment of differently segmented labor markets. Labor markets are pair-wise combinations of occupations and regions. The first value in each cell denotes the probability (in percent) that a worker in a certain labor market and year was already employed in the very same labor market in the year before. The second value in each cell (in parentheses) denotes the probability (in percent) that a newly hired worker in a certain labor market and year was already employed in the very same labor market in the year before (i.e., the probability is conditioned on workers who switch firms). The third value in each cell (in brackets) denotes the potential number of labor markets for the specific delineation. Note that the effective number of labor markets is generally lower because certain combinations of occupation and region may feature zero workers or hires. The yearly transition probabilities are calculated for workers' who are employed in adjacent years and refer to their main job which is the job (with a length of at least 30 days) that earns the highest daily wage in the respective calendar year. KldB = German Classification of Occupations. LAU = Local Administrative Unit. NUTS = Statistical Nomenclature of Territorial Units. Source: BEH, 2012-2023.

attachment to the geographical than the occupational dimension. For instance, commuting zones and detailed 2-digit occupations both slice the overall market into roughly 140 sub-markets and 63.1 percent of hires come from the same commuting zone, but only 39.9 percent come from the same detailed 2-digit occupation.

Interacting both dimensions substantially reduces self-containment, in particular when focusing on hires. Combining 436 detailed 3-digit occupations with 141 commuting zones yields a self-containment of 24.6 percent. Moving to larger categories of occupation or space increases self-containment by 2 percentage points (or 10%) while reducing the number of markets by more than two quarters. Comparing different combinations with similar number of markets yields no clear picture whether using more fine-grained categories in one dimension is superior to using more fine-grained categories in the other dimension.

Table 2 shows the self-containment of labor markets when defining economic activity by industry instead of occupation. Using 38 1-digit industries yields a self-containment rate of 90.4 percent for all workers and 41.0 percent for hires, which is similar to the rates for the 39 detailed 1-digit occupations. Self-containment rates however deteriorate much quicker when using narrower industry classifications than when using narrower occupational categories. For 88 2-digit industries, self-containment is only slightly higher than for 1,300 detailed 4-digit occupations. Also when combining economic activity and region, industry-based labor markets exhibit lower self-containment than occupation-based labor markets. When combined with commuting zones, self-containment is similar for 88 2-digit industries (87.4% or 23.1%) and for 436 detailed 3-digit occupations (86.3% or 24.6%).

Overall, these results show that labor market delineations based on occupations yield higher self-containment than those based on industries. While this pattern may originate from a higher relevance of occupation-specific (than industry-specific) human capital, the difference could also partly be rooted in the dual apprenticeship training system in Germany with its strong focus on defined occupations and a high relevance of formal certificates (Rhein, Trübswetter, and Nisic, 2013). That said, labor markets by occupation and region are still far from fully self-contained.

Regarding the level of spatial aggregation, the results indicate that the current practice of using commuting zones or related concepts is sensible as self-containment rates drop strongly when using smaller delineations. A less clear picture emerges for the level of aggregation for occupations, where more detailed classifications often come at little expense in terms of self-containment.

Through the lens of these findings, we delineate labor markets by 436 detailed 3-digit

occupations (occupational groups) times 141 commuting zones as our baseline specification. This delineation appears well within the range used in the literature and allows us to examine the effects of deviating in both dimensions towards broader and narrower labor market delineations.

## 5 Results on Labor Market Concentration

### 5.1 Variants of Measuring Labor Market Concentration

This subsection describes labor market concentration in Germany and its evolution over time. We start by examining its level and how the decisions described in Section 4 affect the measured concentration. While some choices change the level of concentration mechanically, e.g., smaller, nested labor markets are more concentrated, there is no mechanic relation to the evolution over time. Comparing the evolution hence sheds additional light on the effects of measuring labor market concentration in one or another particular way.

**Baseline Specification.** The first row of Table 3 provides descriptive statistics for our baseline HHI measure and alternative measures, pooled over the years 2012–2023. Our baseline concentration measure refers to the market-level HHI in terms of hires for combinations of detailed 3-digit occupations (occupational groups), commuting zones, and calendar years. The average market-level HHI is 0.257 which, by taking the reciprocal, is equivalent to a labor market with 3.9 equally-sized recruiting firms. To put the average HHI into perspective, a market with four firms with 25 percent hiring shares each or, alternatively, a market with eight firms and shares of 40, 25, 10, 10, 5, 5, 5, and 5 percent would yield a similar value. In terms of the median, 50 percent of the markets feature an HHI of at least 0.125 or, put differently, an equivalent number of at most equally-sized 8.0 firms. The 25th and the 75th percentile are 0.042 and 0.333, respectively, which corresponds to 23.8 and 3.0 equally-sized firms in the market. 44.4 percent of our baseline labor markets feature low levels of concentration, operationalized by an HHI below the 0.1 threshold from EU merger guidelines. 16.9 percent of these markets are moderately concentrated, that is, their HHI ranges between the thresholds of 0.1 and 0.2 from antitrust policy. 38.7 percent of labor markets are highly concentrated (HHI above 0.2).

Panel a of Figure 2 visualizes the distribution of our baseline HHI measure. The distribution is skewed to the right, with a prominent spike at the value of 1. The spike shows that 10.9 percent of markets comprise only one single firm. A second spike occurs at the value of 0.5, implying two equally-sized firms.

Table 2: Self-Containment of Labor Markets Defined By Industries

	Spatial Delineation	None	16 Federal States NUTS-1	38 Government Regions NUTS-2	141 Commuting Zones	400 Districts NUTS-3	10,785 Municipalities LAU
<b>None</b>		100.0 (100.0) [1]	96.8 (79.5) [16]	95.4 (70.6) [38]	94.1 (63.1) [141]	91.5 (47.3) [400]	89.3 (34.0) [10,785]
<b>38</b>		90.4 (41.0) [38]	89.1 (33.1) [608]	88.5 (29.7) [1,444]	88.0 (26.7) [5,358]	87.0 (20.8) [15,200]	86.1 (15.7) [409,830]
<b>Industrial Sections</b> 1-Digit WZ-08							
<b>88</b>		89.3 (34.8) [88]	88.3 (28.4) [1,408]	87.8 (25.5) [3,344]	87.4 (23.1) [12,408]	86.5 (18.1) [35,200]	85.7 (13.7) [949,080]
<b>Industrial Divisions</b> 2-Digit WZ-08							
<b>272</b>		88.2 (28.2) [272]	88.3 (28.4) [4,352]	86.9 (20.6) [10,336]	86.5 (18.6) [38,352]	85.8 (14.6) [108,800]	85.2 (11.2) [2,933,520]
<b>Industrial Groups</b> 3-Digit WZ-08							
<b>615</b>		87.7 (25.8) [615]	87.3 (22.9) [9,840]	86.5 (18.9) [23,370]	86.2 (17.0) [86,715]	85.5 (13.4) [246,000]	84.9 (10.2) [6,632,775]
<b>Industrial Classes</b> 4-Digit WZ-08							
<b>839</b>		87.4 (23.8) [839]	86.9 (21.0) [13,424]	86.3 (17.4) [31,882]	86.0 (15.7) [118,299]	85.3 (12.3) [335,600]	84.7 (9.3) [9,048,615]
<b>Industrial Sub-Classes</b> 5-Digit WZ-08							

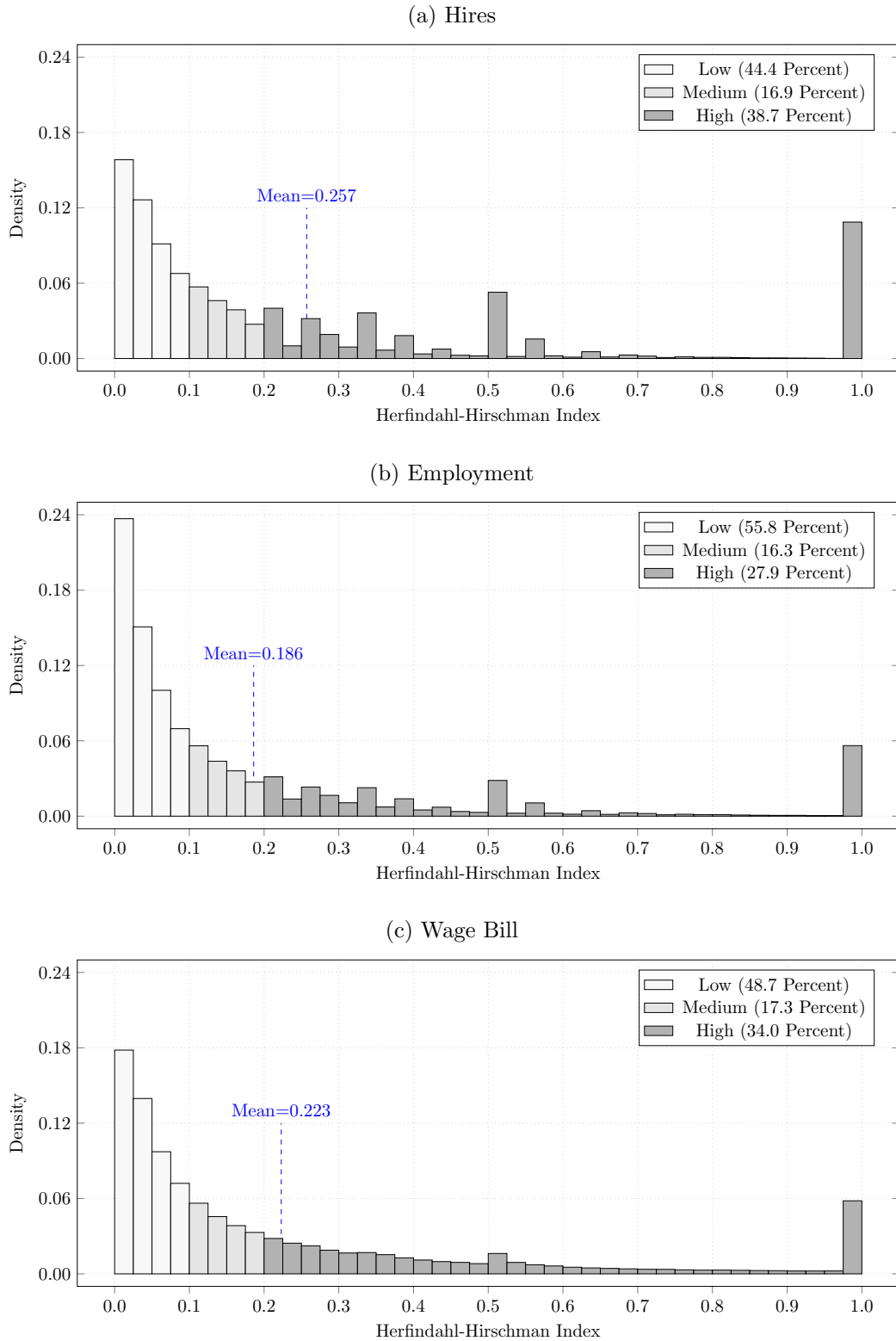
NOTE. — The table displays the self-containment of differently segmented labor markets. Labor markets are pair-wise combinations of industries and regions. The first value in each cell denotes the probability (in percent) that a worker in a certain labor market and year was already employed in the very same labor market in the year before. The second value in each cell (in parentheses) denotes the probability (in percent) that a newly hired worker in a certain labor market and year was already employed in the very same labor market in the year before (i.e., the probability is conditioned on workers who switch firms). The third value in each cell (in brackets) denotes the potential number of labor markets for the specific delineation. Note that the effective number of labor markets is generally lower because certain combinations of industries and region may feature zero workers or hires. The yearly transition probabilities are calculated for workers' who are employed in adjacent years and refer to their main job which is the job (with a length of at least 30 days) that earns the highest daily wage in the respective calendar year. WZ = German Classification of Industries. LAU = Local Administrative Unit. NUTS = Statistical Nomenclature of Territorial Units. Source: BEH, 2012-2023.

Table 3: Descriptive Statistics for Labor Market Concentration

	Mean	P10	P25	P50	P75	P90	Share (0.1-0.2)	Share (0.2-1.0)	Observations
<b>Baseline:</b>									
HHI, Hires, Commuting Zone									
3-Digit KldB-10 (Group) $\times$ Level	0.257	0.016	0.042	0.125	0.333	1.000	0.169	0.387	484,008
<b>Alternative Occupational Dimension:</b>									
1-Digit KldB-10 (Area) $\times$ Level	0.049	0.003	0.006	0.014	0.041	0.107	0.060	0.049	51,972
2-Digit KldB-10 (Main Group) $\times$ Level	0.122	0.007	0.017	0.049	0.130	0.331	0.145	0.170	181,417
4-Digit KldB-10 (Sub-Group) $\times$ Level	0.393	0.034	0.091	0.250	0.556	1.000	0.158	0.574	1,043,139
<b>Alternative Spatial Dimension:</b>									
NUTS-1 (Federal State)	0.110	0.003	0.009	0.031	0.105	0.306	0.107	0.152	64,702
NUTS-2 (Government Region)	0.138	0.006	0.015	0.046	0.143	0.375	0.129	0.197	150,493
NUTS-3 (District)	0.343	0.033	0.079	0.207	0.500	1.000	0.180	0.519	1,213,452
LAU (Municipality)	0.661	0.160	0.333	0.654	1.000	1.000	0.079	0.870	6,493,534
<b>Alternative Measure of Firm Size:</b>									
Employment	0.186	0.011	0.027	0.079	0.224	0.500	0.163	0.279	544,531
Wage Bill	0.223	0.015	0.037	0.105	0.294	0.637	0.173	0.340	544,531
<b>Alternative Concentration Index:</b>									
Inverse Number of Firms	0.217	0.006	0.019	0.077	0.250	1.000	0.129	0.322	484,008
1-Firm Concentration Ratio	0.328	0.056	0.107	0.222	0.500	1.000	0.225	0.548	484,008
3-Firm Concentration Ratio	0.535	0.133	0.241	0.464	0.900	1.000	0.134	0.808	484,008
5-Firm Concentration Ratio	0.627	0.187	0.333	0.619	1.000	1.000	0.088	0.887	484,008

NOTE. — The table displays descriptive statistics for labor market concentration in Germany. Labor markets refer to pair-wise combinations of occupations and commuting zones, and are tracked with annual frequency. The baseline concentration refers to the market-level Herfindahl-Hirschman Index for hiring shares in yearly combinations of 3-digit KldB-2010 occupations (along with their requirement level) and commuting zones from Kosfeld and Werner (2012). The requirement level differentiates between jobs for helpers, professionals, specialists, and experts. HHI = Herfindahl-Hirschman Index. KldB = German Classification of Occupations. LAU = Local Administrative Units. NUTS = Statistical Nomenclature of Territorial Units. PX = Xth Percentile. Source: BEH, 2012-2023.

Figure 2: Distribution of Labor Market Concentration



NOTE. — The figure illustrates the distribution of labor market concentration in Germany. Labor market concentration refers to HHI values for pair-wise combinations of 3-digit KldB-2010 occupations (along with their requirement level) and commuting zones from Kosfeld and Werner (2012), and is tracked with annual frequency. The three histograms refer to the concentration of new hires, employment, and wage bill, respectively. HHI = Herfindahl-Hirschman Index. KldB = German Classification of Occupations. Source: BEH, 2012-2023.

**Alternative Labor Market Definitions.** We first examine the sensitivity of our baseline HHI measurement with regard to broader or narrower labor market definitions by occupations. Using the broader detailed 1-digit or detailed 2-digit occupations, average HHI decreases to 0.049 and 0.122, mirroring 20.4 and 8.2 equally-sized firms in the market. For the narrower detailed 4-digit occupations, the equivalent number of firms shrinks from 3.9 to 2.5 ( $\overline{\text{HHI}}=0.393$ ).

When relying on administrative rather than functional regions, the use of broader NUTS-1 regions ( $\overline{\text{HHI}}=0.110$ ) or NUTS-2 regions ( $\overline{\text{HHI}}=0.138$ ) approximately halves our baseline HHI average (equivalent to 9.1 and 7.2 equally-sized firms, respectively). By contrast, the average HHI turns out substantially higher for the narrower NUTS-3 regions ( $\overline{\text{HHI}}=0.343$ ) corresponding to 2.9 equally-sized firms. The use of LAU regions, which refers to the most local unit in terms of municipalities, nearly triples our baseline ( $\overline{\text{HHI}}=0.661$ ), indicating an equivalent number of only 1.5 equally-sized firms hires workers in a certain combination of detailed 3-digit occupation and municipality over the course of a year.

Table 3 also allows us to compare labor market concentration for different delineations with similar numbers of observations, which we can consider as an indicator of aggregation. Combining finer NUTS-3 regions with our baseline occupations yields less concentrated markets than combining our baseline commuting zones with detailed 4-digit occupations, even despite a higher number of observations. Conversely, combining the broader NUTS-1 or NUTS-2 regions with our baseline occupations reduces the measured concentration less than combining our baseline commuting zones with broader occupations. Overall, these patterns suggest that a change in the degree of occupational aggregation has a stronger effect on measured concentration than a similar change in the spatial aggregation.

**Alternative Measures of Firm Size.** Next, we vary our measure of firms' size and report labor market concentration based on employment and wage bill, which enjoy intuitive appeal in certain oligopsony-style models.<sup>14</sup> Employment and wage bills are a little less concentrated than hires, featuring average HHI values of 0.186 and 0.223—equivalent to 5.4 and 4.5 equally-sized firms, respectively. The share of moderately and highly concentrated labor markets shrinks from 55.6 percent (hires) to 44.2 percent (employment) or 51.3 percent (wage bill). Panel b and c of Figure 2 visualize the distribution of employment and wage bill concentration. Since the calculation of wage bill shares is not based on integer values, the distribution of wage bill concentration is markedly smoother than those for hires and employment, though

<sup>14</sup>The number of employed workers always exceeds the number of hires, thus reducing the number of labor markets with empty cells.



the distribution of the three measures turn out fairly similar, overall.

To provide a more detailed comparison, Table 4 gives the pair-wise correlations of the three measures, showing the Bravais-Pearson correlations in levels and logs as well as the Spearman rank correlation. The hiring HHI correlates strongly with the two other measures. In logs, the correlations prove to be somewhat greater than in absolute values, reaching 0.89 (with employment) and 0.85 (with wage bill). The correlation between employment HHI and wage-bill HHI is even stronger and amounts to roughly 0.95. When instead relying on Spearman rank correlation coefficients, the correlations turn out similarly strong as those in logs.

By and large, the strong correlations highlight that the choice of the firm size variable generally has smaller effects on the measured labor market concentration than the delineation of labor markets. Given the strong correlations, it also appears unlikely that the definition of firms' size has a strong bearing on regression results—especially when running log-linear models.

Table 4: Correlation between HHI Measures

	<b>HHI Hires</b>	<b>HHI Employment</b>	<b>HHI Wage Bill</b>
<b>HHI Hires</b>	1.000 (1.000) [1.000]		
<b>HHI Employment</b>	0.715 (0.890) [0.881]	1.000 (1.000) [1.000]	
<b>HHI Wage Bill</b>	0.704 (0.852) [0.842]	0.942 (0.968) [0.967]	1.000 (1.000) [1.000]

NOTE. — The table displays the correlations between different HHI measures. Labor market concentration refers to HHI values for pair-wise combinations of 3-digit KldB-2010 occupations (along with their requirement level) and commuting zones from Kosfeld and Werner (2012), and is tracked with annual frequency. The first value in each cell denotes the Bravais-Pearson correlation coefficient between the HHI values in levels. The second value in each cell (in parentheses) denotes the Bravais-Pearson correlation coefficient between the HHI values in logs. The third value in each cell (in brackets) denotes the Spearman rank correlation coefficient between the HHI values. The number of observations is 484,008. HHI = Herfindahl-Hirschman Index. KldB = German Classification of Occupations. Source: BEH, 2012-2023.

**Alternative Concentration Indices.** We proceed with separately analysing the fewness and unevenness dimension of labor market concentration. The inverse number of firms, which isolates the fewness of employers, averages 0.217. This corresponds to 4.6 recruiting firms of equal size compared to 3.9 equally-sized firms according to our baseline. Thus, focusing on the fewness suggests less concentrated labor markets than the HHI, which also includes an

unevenness dimension.

In terms of concentration ratios, the hiring share of the single largest firm in the average labor market is 32.8 percent. The share of the three and five largest firms in the average market amounts to 53.5 and 62.7 percent, respectively. The cumulative distribution of the concentration indices shows the fraction of markets with employers in a dominant market position by the standards of German antitrust law (see Appendix Figure B1).<sup>15</sup> The concentration ratios indicate a dominant market position for 29.8 percent of the labor markets using the 1-firm concentration ratio and for 48.4 and 47.3 percent of the markets using the 3- and 5-firm concentration ratios. Compared to the 38.7 percent of markets that are highly concentrated according to the HHI, labor markets thus appear more or less concentrated when using concentration ratios instead of the HHI depending on the number of included firms.

**Evolution over Time.** The comparisons so far have focused on the measured level of concentration when using different concepts. To shed more light on the consequences for empirical applications, we now turn to the evolution of labor market concentration over time. Figure 3 contrasts the evolution of our baseline HHI values for the years 2012–2023 with the evolution when using different delineations of labor markets (Panels a and b), measures of firms’ size (Panel c), and indices of concentration (Panel d).

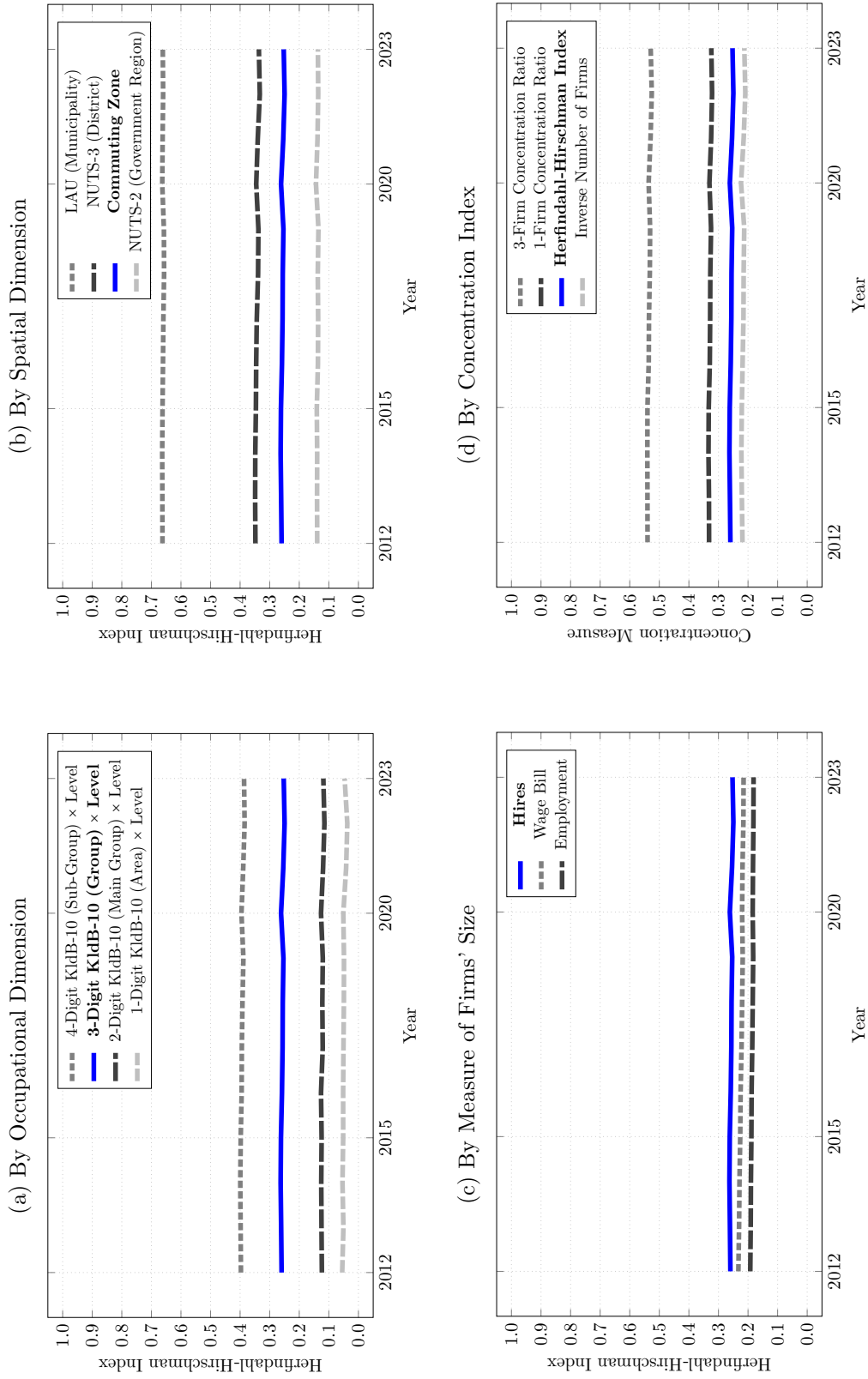
For our baseline specification, namely the HHI for hires in the same detailed 3-digit occupation and commuting zone, the average concentration has hardly changed between 2012 ( $\overline{\text{HHI}}=0.260$ ) and 2023 ( $\overline{\text{HHI}}=0.253$ ).<sup>16</sup> In 2020, we observe a small increase in hiring concentration, which likely reflects that many firms stopped hiring at the beginning of the Covid-19 pandemic.

Comparing the alternative measurements to our baseline shows the substantial differences in the extent of labor market concentration described earlier, but does not indicate effects on the measured evolution. Irrespective of the measurement, we find labor market concentration to have remained stable between 2012 and 2023. The slight increase in concentration in 2020 is visible with all measures but employment and wage bill. These measures of firms’ size appear more stable—or sluggish—in event of sudden changes. Depending on the research question this may be a desired property or suggest to use a hiring-based measure of concentration.

<sup>15</sup>As detailed in Section 2.3, firms are considered to have a dominant market position, if one, three or five firms have a combined market share of at least 40 percent, 50 percent, or two thirds, respectively.

<sup>16</sup>The same pattern also holds true for the 25th percentile, the median, and the 75th percentile (see Appendix Figure B2).

Figure 3: Labor Market Concentration Over Time



NOTE. — The figure visualizes average labor market concentration over time for different occupational dimensions, spatial dimensions, measures of firms' size, and concentration indices. KldB = German Classification of Occupations. LAU = Local Administrative Units. NUTS = Statistical Nomenclature of Territorial Units. Source: BEH, 2012-2023.

## 5.2 Differences in Concentration Across Labor Markets

This subsection documents the differences in concentration across labor markets by market characteristics, occupations, and commuting zones as of 2022 (the final year for which detailed occupational information is available). For most of this analysis, we continue to rely on the HHI of hires in combinations of detailed 3-digit occupations and commuting zones, restricting the sample to markets with at least one hire in that year.

**Market Size and Self-Containment.** We first examine systematic differences in labor market concentration between markets of different size and by their self-containment. We use the logged number of hires as a proxy for market size. The self-containment rate is defined as in Section 4, but now calculated for each market separately. Column 1 of Table 5 displays the result of cross-sectional OLS regressions of our baseline HHI values (in levels) on these two variables.

The results show that larger labor markets are less concentrated. Specifically, an increase in the number of hires in a market by 100 log points reduces the average HHI c.p. by 0.084. Further, more self-contained markets are less concentrated. An increase in the self-containment rate by 10 percentage points comes along with a reduction in the average HHI by 0.005. How to interpret the negative relation between concentration and self-containment is not clear. It could reflect workers need to move across labor markets when concentration is high or their ability to avoid highly concentrated markets. Taken together, the two variables have a remarkably high predictive power for labor market concentration as indicated by the  $R^2$  of 0.449.

**Occupational Heterogeneity.** Next, we examine the heterogeneity of labor market concentration along the occupational dimension. Figure 4 depicts the average HHI by 2-digit occupations.<sup>17</sup> Concentration varies substantially between occupations. The 2-digit occupation with the highest average HHI is nearly seven times more concentrated than that with the lowest average HHI. The five least concentrated 2-digit occupations are: business management and organization (0.087), sales retail trade, technical machine-building, financial services and tax consultancy, and cleaning services (0.126). At the other end of the distribution, the five 2-digit occupations with the highest average HHI are: philology, humanities, and economics (0.574), production and processing of raw materials, product design and artisan craftwork,

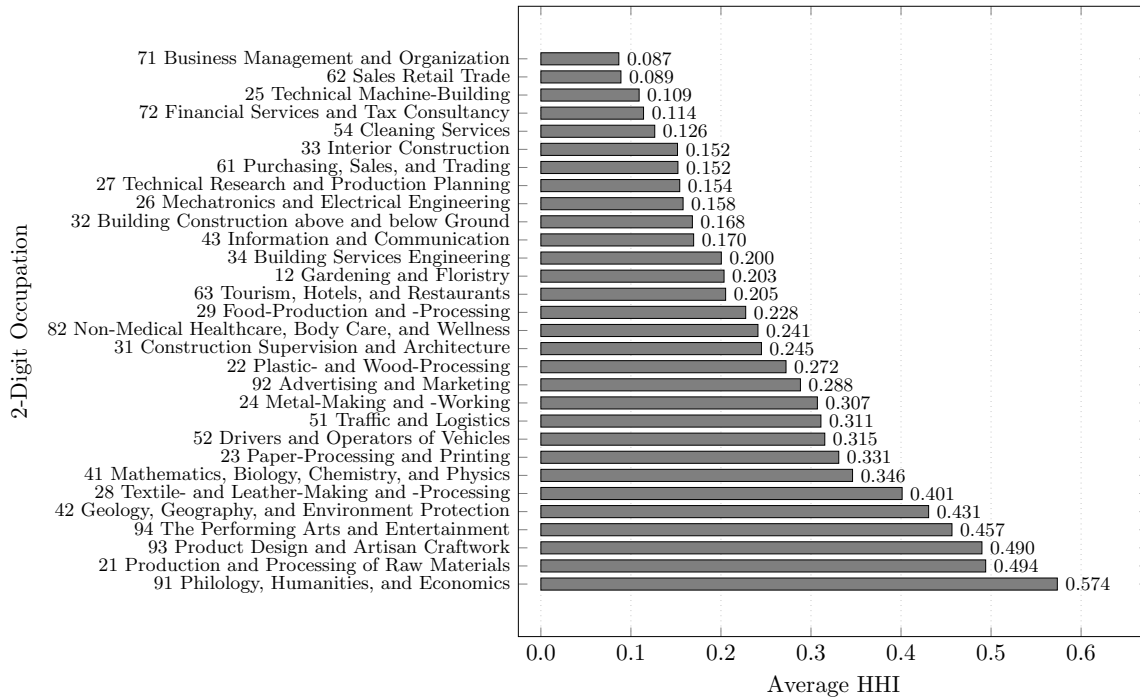
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<sup>17</sup>For this exercise and the results by commuting zone, we first obtain the HHI for labor markets delineated by detailed 3-digit occupation times commuting zone (i.e., our baseline specification) and then average by broader categories.

the performing arts and entertainment, and geology, geography, and environment protection (0.431). At the 3-digit level (see Appendix Figure B3), average concentration even varies from 0.012 (vehicle drivers in road traffic) to 0.743 (maintenance of traffic infrastructure).

To shed light on systematic differences by occupational characteristics, we examine the relationship between occupations' task content and labor market concentration, see Column 2 in Table 5. Through the lens of the task-based approach (Autor, Levy, and Murnane, 2003), we differentiate between five different task groups and use the German Occupational Panel (Grienberger, Janser, and Lehmer, 2023) to assign each detailed 3-digit occupation the shares of their occupation-specific tasks in these five task groups. Labor market concentration turns out higher for occupations with a high share of manual routine tasks and for those with a high share of analytical non-routine tasks. High shares of manual routine tasks are often found in highly specialized manufacturing occupations (e.g., the 2-digit occupation production and processing of raw materials), whereas high shares of analytical non-routine tasks are typical for academic or creative occupations (e.g., philology, humanities, and economics).

Figure 4: Labor Market Concentration by 2-Digit Occupation



NOTE. — The figure displays average labor market concentration by 2-Digit KldB-10 occupations in Germany. Labor market concentration refers to HHI values (based on hiring shares) for pair-wise combinations of 3-digit KldB-2010 occupations (along with their requirement level) and commuting zones from Kosfeld and Werner (2012), and is tracked with annual frequency. HHI = Herfindahl-Hirschman Index. KldB = German Classification of Occupations. Source: BEH, 2012-2023.

**Spatial Heterogeneity.** Figure 5 visualizes the heterogeneity of the baseline HHI values by commuting zones. The more densely populated areas in southern and western Germany and metropolitan areas generally feature lower HHI levels, whereas the northern and eastern parts of Germany and rural areas exhibit higher HHI values. The five commuting zones with the on average least concentrated labor markets all include large cities: Hamburg (0.094), Munich, Berlin, Stuttgart, and Frankfurt/Main (0.123). The five commuting zones with the on average most concentrated labor markets in contrast are rural: Prignitz (0.447), Vulkaneifel, Kronach, Stendal, and Uckermark (0.429).

Column 3 of Table 5 corroborates this pattern. Holding constant the geographical area, labor markets in more populous regions are less concentrated. An increase in population by 100 log points comes along with a decrease in the average HHI by 0.052. In this model, however, we find no economically or statically significant relationships between labor market concentration and geographical area or the GDP as two other prominent regional characteristics.

**Combining the Three Dimensions.** Across the three dimensions, some characteristics plausibly correlate with each other, such as the size of a labor market and the population of a region. Column 4 of Table 5 therefore presents the results of a regression simultaneously including labor market, occupational, and spatial variables. Compared to the regressions in Column 1, the coefficients of labor markets' size and self-containment are almost unaffected by including the other control variables. Regarding the task content of occupations, the associations become much weaker to inexistent. Only the association between the share of manual routine tasks remains statistically significant—albeit only at the 10 percent level—and the coefficient shrinks to one third of its previous size. Turning to the regional characteristics, holding fixed the market size weakens the relation between population and concentration, though it remains statistically significant and economically meaningful. Further, a positive association between concentration and regional GDP emerges, probably reflecting the presence of more productive and larger firms, which leads to higher labor market concentration.

### 5.3 Worker-Level Perspective

This subsection switches from a market-level perspective to a worker-level perspective documenting the fraction of workers who work in concentrated labor markets and their characteristics.

Table 5: Predictors of Labor Market Concentration

	(1) HHI	(2) HHI	(3) HHI	(4) HHI
Intercept	0.509*** (0.003)	0.040 (0.076)	0.759*** (0.109)	0.273** (0.106)
<b>Labor Market Variables:</b>				
Log Hires	-0.084*** (0.001)			-0.086*** (0.004)
Self-Containment Rate	-0.051*** (0.007)			-0.044*** (0.015)
<b>Occupational Variables:</b>				
Share Manual Routine Tasks		0.239*** (0.078)		0.076* (0.040)
Share Manual Non-Routine Tasks		0.002 (0.083)		-0.012 (0.047)
Share Cognitive Routine Tasks		0.112 (0.085)		-0.034 (0.042)
Share Interactive Non-Routine Tasks		Reference Group		Reference Group
Share Analytical Non-Routine Tasks		0.341*** (0.091)		-0.020 (0.048)
<b>Spatial Variables:</b>				
Log Population (in 1,000s)			-0.052*** (0.013)	-0.026** (0.011)
Log Area (in km <sup>2</sup> )			0.004 (0.003)	0.000 (0.003)
Log GDP (in 1,000 Euro)			-0.016 (0.011)	0.025*** (0.009)
<hr/>				
Labor Market Definition	Detailed 3-Digit Occupation × Commuting Zone			
Standard Error Clustering	None	Occupation	CZ	Occupation CZ
Number of Observations	37,166	37,166	37,166	37,166
R <sup>2</sup>	0.449	0.047	0.058	0.459

NOTE. — The table displays cross-sectional OLS regressions of our baseline HHI values on labor market, occupational, and spatial variables for the year 2022. Labor market concentration refers to HHI values (based on hiring shares) for pair-wise combinations of 3-digit KldB-2010 occupations (along with their requirement level) and commuting zones from Kosfeld and Werner (2012). Unlike all other variables, the data on GDP refer to the year 2021. Robust standard errors in parentheses, Column 4 applies two-way clustering. CZ = Commuting Zone. HHI = Herfindahl-Hirschman Index. \* =  $p < 0.10$ . \*\* =  $p < 0.05$ . \*\*\* =  $p < 0.01$ . Sources: BEH + Occupational Panel + Destatis, 2022.

**Concentration at the Worker Level.** Our finding that larger labor markets are less concentrated implies that the share of workers in concentrated labor markets is smaller than the share of concentrated markets. To examine this pattern, the first row of Table 6 weights our baseline HHI values by employment in the respective labor markets. At the worker level, the average baseline HHI amounts to 0.037, implying that the average worker engages in a market with 25.6 equally-sized firms. In terms of the 25th, 50th, and 75th percentile, the

equivalent numbers of firms are 200.0 ( $\overline{\text{HHI}}=0.005$ ), 76.9 ( $\overline{\text{HHI}}=0.013$ ), and 29.4 ( $\overline{\text{HHI}}=0.034$ ). Taken together, 5.0 and 3.7 percent of workers are employed in moderately and in highly concentrated labor markets, respectively, as given by the EU antitrust thresholds, compared to 16.9 and 38.7 percent of labor markets. The share of workers in concentrated labor markets is thus substantially lower than the share of concentrated markets.

**Heterogeneity By Worker Characteristics.** In the remaining rows of Table 6, we scrutinize whether the extent of labor market concentration is varying by five worker characteristics. In this respect, we weight the baseline HHI values with the respective number of workers per sub-group in the labor market. First, we find a U-shaped pattern regarding the requirement level as a measure of workers education. While 6.1 percent of professionals (i.e., those jobs that require vocational training) engage in moderately and highly concentrated markets, these shares are markedly higher for helpers (9.0 percent), specialists (14.0 percent), and experts (16.3 percent). Second, we also observe systematic differences between men and women. 10.1 percent of men engage in moderately or highly concentrated labor markets, but only 6.6 percent of women. Third, labor market concentration does not differ fundamentally by nationality: 8.8 percent of workers with German nationality and 7.9 percent of those with foreign nationality are working in moderately and highly concentrated markets. Fourth, labor market concentration turns out lower for workers in West Germany, where 8.3 percent of workers engage in markets with medium or high concentration, than in East Germany, where 10.6 percent do so. Fifth, we find notable differences in labor market concentration by contract type. Workers with full-time jobs appear more often in concentrated labor markets (10.6%) than workers with regular part-time jobs (6.6%) and marginal part-time jobs (5.6%). All of these described qualitative patterns also hold when examining the average HHI rather than the shares in concentrated labor markets.

#### 5.4 Results by Industry

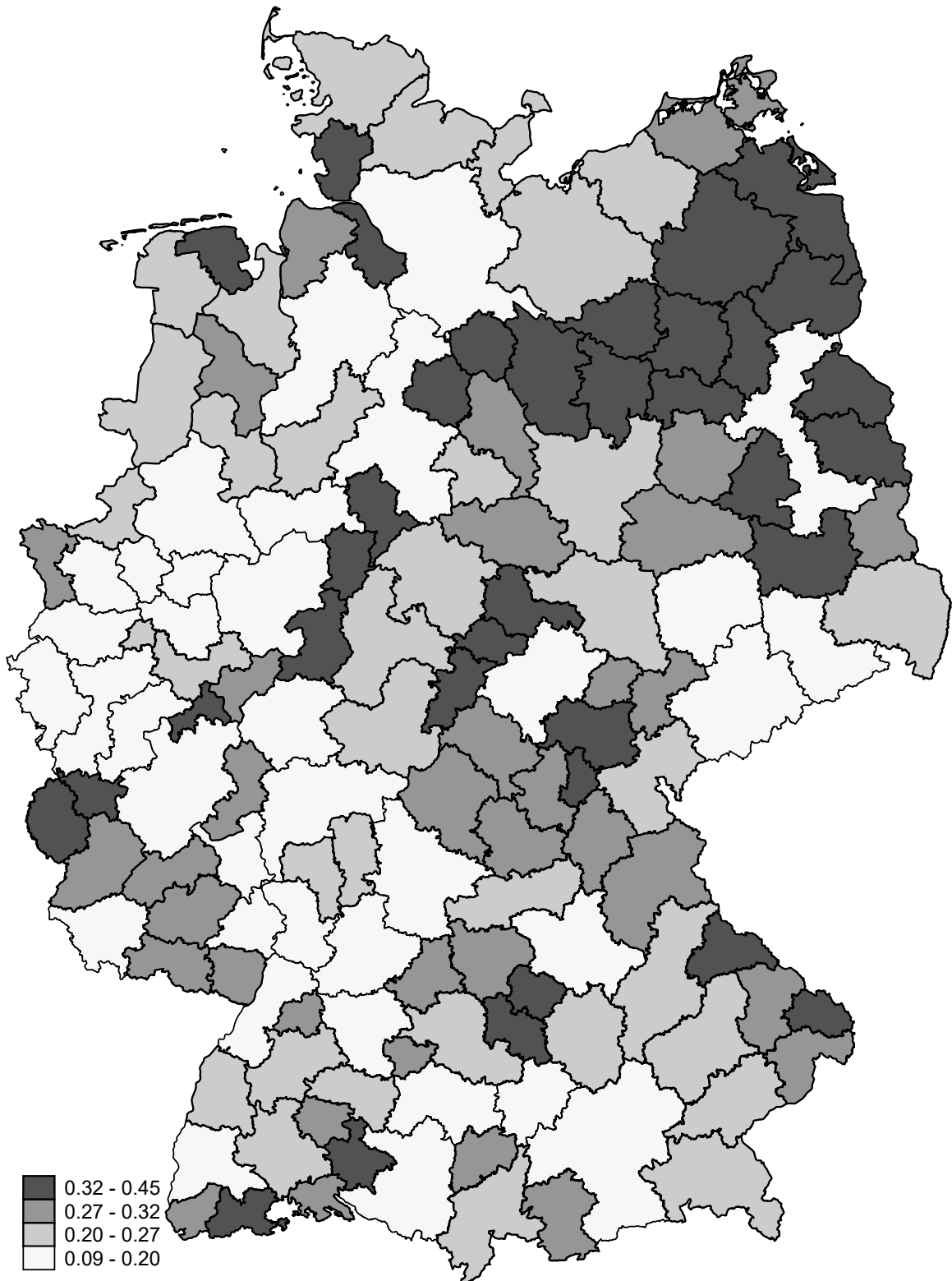
Guided by higher self-containment rates, we solely focused on the concentration of occupational labor markets in our previous considerations. In the following, we will also briefly describe key characteristics of labor market concentration by industry.

As our baseline, we calculate HHI values for hires in combinations of 615 4-digit industries (industrial classes), 141 commuting zones, and calendar years.<sup>18</sup> For the years 2012–2023, the

<sup>18</sup>The 3-digit level (272 industrial groups) and 4-digit level (615 industrial classes) come closest to our 436 detailed 3-digit occupations. We choose the 4-digit industry classification as baseline because—as with detailed 3-digit occupations—this is the second finest level available and the literature tends to use relatively fine-grained indicators of economic activities.



Figure 5: Labor Market Concentration by Commuting Zone



NOTE. — The map displays average labor market concentration by commuting zones in Germany. Labor market concentration refers to HHI values (based on hires) for pair-wise combinations of 3-digit KldB-2010 occupations (along with their requirement level) and commuting zones from Kosfeld and Werner (2012), and is tracked with annual frequency. HHI = Herfindahl-Hirschman Index. KldB = German Classification of Occupations. Source: BEH, 2012-2023.

Table 6: Descriptive Statistics for Labor Market Concentration by Worker Characteristics

	Mean	P10	P25	P50	P75	P90	Share (0.1-0.2)	Share (0.2-1.0)	Observations
<b>Baseline (Worker-Weighted):</b>									
All Workers	0.039	0.003	0.005	0.013	0.034	0.088	0.050	0.037	464,275,698
<b>By Requirement Level:</b>									
Helpers	0.041	0.004	0.007	0.016	0.038	0.092	0.053	0.037	113,024,345
Professionals	0.029	0.002	0.004	0.010	0.026	0.065	0.038	0.023	257,587,662
Specialists	0.059	0.003	0.007	0.019	0.053	0.139	0.071	0.069	52,118,294
Experts	0.064	0.004	0.008	0.022	0.060	0.160	0.085	0.078	41,545,397
<b>By Gender:</b>									
Male	0.043	0.003	0.006	0.015	0.039	0.101	0.058	0.043	268,700,533
Female	0.032	0.002	0.004	0.011	0.027	0.070	0.039	0.027	195,575,165
<b>By Nationality:</b>									
German	0.039	0.003	0.005	0.013	0.035	0.089	0.051	0.037	396,233,816
Foreign	0.036	0.003	0.005	0.012	0.031	0.081	0.045	0.034	67,810,597
<b>By Region:</b>									
West Germany	0.037	0.003	0.005	0.013	0.033	0.085	0.048	0.035	387,293,918
East Germany	0.046	0.003	0.006	0.015	0.041	0.106	0.059	0.047	76,981,780
<b>By Contract Type:</b>									
Regular Full-Time	0.045	0.003	0.006	0.016	0.041	0.105	0.060	0.046	255,554,908
Regular Part-Time	0.031	0.002	0.004	0.010	0.027	0.069	0.039	0.027	87,532,925
Marginal Part-Time	0.028	0.002	0.004	0.010	0.024	0.062	0.034	0.022	99,773,558

NOTE. — The table displays descriptive statistics for labor market concentration by worker characteristics in Germany. Labor markets refer to pair-wise combinations of occupations and commuting zones, and are tracked with annual frequency. The baseline concentration refers to the worker-weighted Herfindahl-Hirschman Index for hiring shares in yearly combinations of 3-digit KldB-2010 occupations (along with their requirement level) and commuting zones from Kosfeld and Werner (2012). The requirement level differentiates between jobs for helpers, professionals, specialists, and experts. CZ = Commuting Zone. HHI = Herfindahl-Hirschman Index. KldB = German Classification of Occupations. LAU = Local Administrative Units. NUTS = Statistical Nomenclature of Territorial Units. PX = Xth Percentile. Source: BeH, 2012-2023.

average market-level HHI is 0.435 which, in terms of the reciprocal, corresponds to a labor market with 2.3 equally-sized employers (see Appendix Table C1). 14.9 and 64.9 percent of the labor markets are moderately and highly concentrated, respectively. Unlike for occupations, changes in the degree of industrial aggregation do not have a markedly stronger effect on concentration than similar changes in the spatial aggregation. As before, the choice of the firm size variable has hardly any effect on the level of measured concentration. The hiring shares of the largest, the three largest, and the five largest firms in the average labor market are 52.3, 74.2 and 81.6 percent.

Defining labor markets by industry instead of occupation thus increases the measured concentration. Using (38) 1-digit industries instead of (39) detailed 1-digit occupations raises the average HHI from 0.049 to 0.145 and the share of moderately and highly concentrated markets from 10.9 percent to 38.1 percent. Similarly, measured concentration is substantially higher when using (839) 5-digit industries instead of (1,300) detailed 4-digit occupations.

In terms of heterogeneity across 1-digit industries, we observe generally lower concentration for service than manufacturing sectors (see Appendix Figure C1). The 1-digit industries with the lowest average HHI are: real estate activities (0.133), professional service activities (0.141), and accommodation and catering (0.173). At the other end, the most concentrated 1-digit industries are: manufacture of textiles (0.697), manufacture of chemical products (0.705), and manufacture of petroleum products (0.791). In terms of spatial distribution, our results by industry confirm our previous finding that commuting zones in southern and western Germany and metropolitan areas exhibit generally lower concentration levels than zones in northern and eastern Germany and more rural areas (see Appendix Figure C2).

## 6 Conclusions

Our findings have at least three implications for future research that relies on measures of labor market concentration. First, labor markets defined by occupations are more self-contained than labor markets defined by industry. This suggests delineating labor markets by occupation (and region) when feasible. Second, how fine-grained labor markets are delineated strongly influences the measured extent of labor market concentration, though patterns in the evolution over time appear robust to these choices. Although this is somewhat good news, it still underscores the need to report findings with different delineations and ideally report self-containment of markets to help readers critically assess the results. Third, the choice of a firm size variable does not appear to substantially affect measured concentration. For future empirical work, showing the robustness in terms of the firm size variable is of course

advisable, although this issue appears less crucial than the market delineation.

To put our results into perspective, we compare previous evidence from the U.S. with our findings. Handwerker and Dey (2024) report results for the private sector delineating labor markets by roughly 460 occupations and 400 Metropolitan Statistical Areas, which is comparable to our baseline specification as the U.S. has roughly four times the population of Germany. Their average employment-based HHI of 0.033 at the worker-level is similar to the average HHI of 0.037 at the worker-level in Germany. Comparing the level of concentration in our setting with those of Azar et al. (2020) is not feasible because they use substantially narrower occupational codes.

Regarding differences in concentration across labor markets, our findings, along with those of Handwerker and Dey (2024) and Azar et al. (2020), underscore that smaller and more rural labor markets tend to be more concentrated. This pattern is consistently visible—despite variations in definitions. In contrast, a consistent pattern in the relationship between workers' education and labor market concentration has yet to emerge. While Azar et al. (2020) find no link between the two, Handwerker and Dey (2024) document higher concentration for more highly educated workers, and our own results suggest a U-shaped relationship. Further research on which groups of workers are most affected by labor market concentration thus remains a promising avenue for future study.

The extent of concentration in product markets offers an alternative point of comparison for our results. The German Monopolies Commission (2024) defines the relevant product market as the 4-digit industry at the national level. Over the last decade, product market concentration remained relatively stable at an average market-level HHI of 0.1. Thus, labor markets are more concentrated than product markets unless one subscribes to a definition of the relevant labor market that is substantially broader than our baseline. The comparatively high level of labor market concentration suggests that examining labor markets should be an integral part of antitrust policy. This suggestion is further supported by research employing alternative methods to assess labor market power in Germany, including estimates of wage markdowns relative to the marginal product of labor (Dobbelaere et al., 2024) and analyses of firm-level labor supply elasticities (Hirsch, Schank, and Schnabel, 2010; Bachmann, Demir, and Frings, 2022; Hirsch et al., 2022).

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# Appendix

## Labor Market Concentration in Germany

Michael Oberfichtner & Martin Popp

### Content

<b>A Further Details on Data and Sample Definition . . . . .</b>	<b>2</b>
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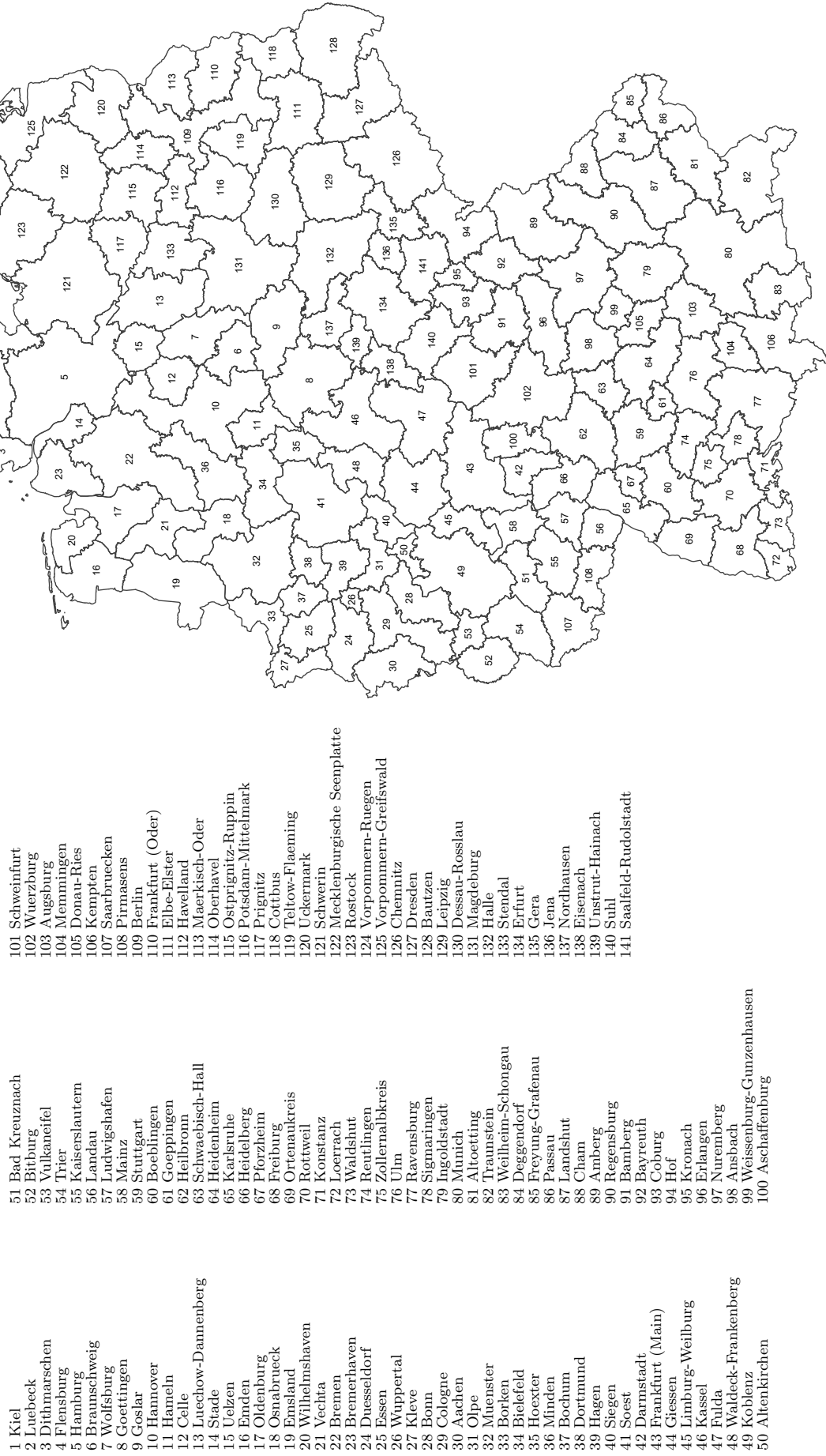
## A Further Details on Data and Sample Definition

Table A1: Representativeness Heuristic

	Disregarded Occupations
<b>39 Detailed</b>	0 Military Occupations (2,3,4)
<b>Occupational Areas</b>	1 Agriculture, Forestry, Farming, and Gardening (1)
1-Digit KldB-10 × Level	8 Health, Social Affairs, and Education (2,3,4)
	01 Armed Forces Personnel (2,3,4)
	11 Agriculture, Forestry, and Farming (1,2,4)
	73 Law and Public Administration (1,2,3)
<b>135 Detailed</b>	81 Medicine and Health Care (1,2,3,4)
<b>Occupational Main Groups</b>	82 Non-Medical Healthcare, Body Care, and Wellness (1,4)
2-Digit KldB-10 × Level	83 Education, Social Work, and Housekeeping (1,2,3,4)
	84 Teaching and Training (2,3,4)
	91 Philology, Humanities, and Economics (4)
	011 Commissioned Officers (4)
	012 Senior Non-Commissioned Officers (3)
	013 Junior Non-Commissioned Officers (2)
	014 Armed Forces Personnel in Other Ranks (2)
	111 Farming (1,2)
	112 Animal Husbandry (1,2,3,4)
	113 Horsekeeping (2,3,4)
	114 Fishing (1,2,3)
	115 Animal Care (1,2,3)
	116 Vini-/Viticulture (2,3,4)
	117 Landscaping and Hunting (1,2,4)
	512 Maintenance of Traffic Infrastructure (2)
	525 Drivers of Other Vehicles (3)
	532 Police and Jurisdiction (1,2,3,4)
	533 Public Control (2,3)
	731 General Law and Jurisdiction (3)
	732 Public Administration (1,2,3,4)
	733 Media and Documentation (2,4)
<b>436 Detailed</b>	811 Doctors' Receptionists and Assistants (2,3)
<b>Occupational Groups</b>	812 Laboratory Medicine (2,3,4)
3-Digit KldB-10 × Level	813 Nursing and Emergency Medical Services (1,2,3,4)
	814 Human Medicine and Dentistry (4)
	816 Psychology and Non-Medical Psychotherapy (3,4)
	817 Non-Medical Therapy and Alternative Medicine (2,3,4)
	821 Geriatric Care (1,2,3,4)
	822 Health Counselling and Wellness (3)
	831 Education and Social Work (1,2,3,4)
	832 Housekeeping and Consumer Counselling (1,2,3)
	841 Teachers in General Education (3,4)
	842 Teachers in Vocational Education (3,4)
	843 Teachers/Researchers at Universities (4)
	844 Teachers in Non-School Education (2,3,4)
	845 Driving, Flying, and Sports Instructors (4)
	913 The Social Sciences (4)
	936 Musical Instrument Making (4)
	947 Museums and Exhibitions (2,3,4)

NOTE. — The table displays those entries in the 2010 version of the German Classification of Occupations (KldB) that do not pass our representativeness heuristic. Specifically, we disregard all military occupations and those occupations whose underlying share of workers in the non-agricultural private business sector is not exceeding 50 percent in the BEH. Requirement levels (in parentheses) refer to either helpers (1), professionals (2), specialists (3), or experts (4). Source: BEH, 2012-2023.

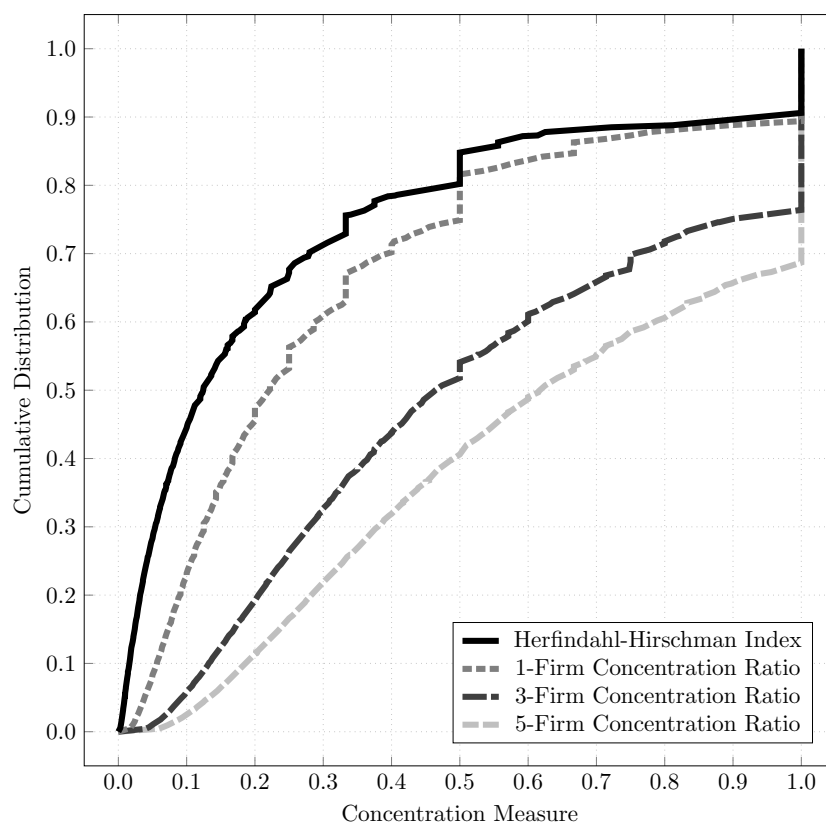
Figure A1: Commuting Zones



NOTE. — The figure illustrates the delineation of Germany into 141 commuting zones. The labels indicate the main district of each zone. Source: Kosfeld and Werner (2012).

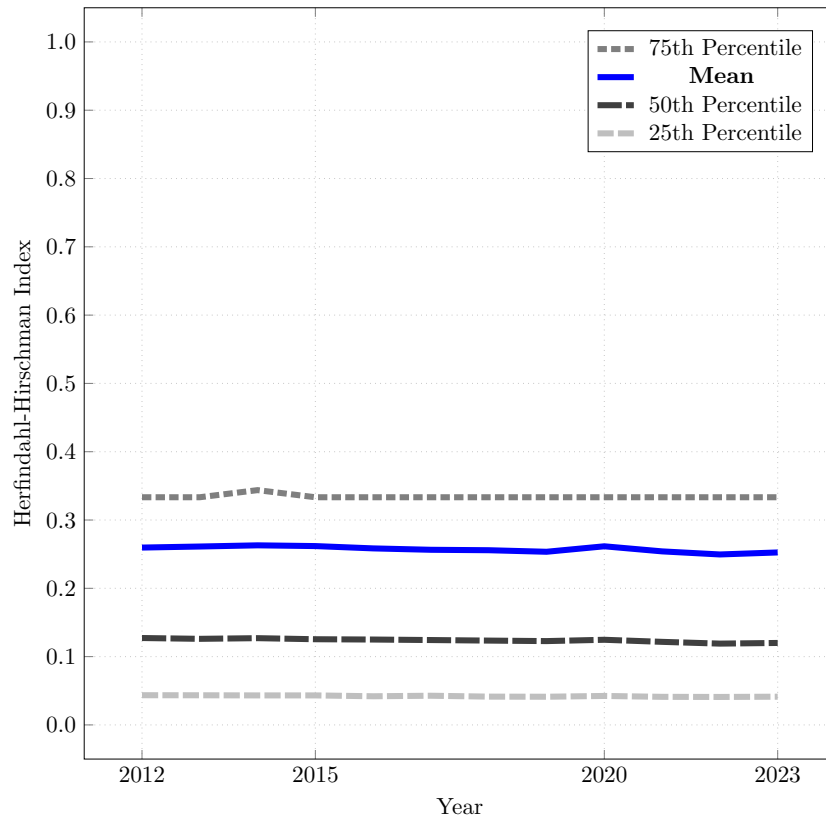
## B Further Results on Labor Market Concentration by Occupation

Figure B1: Cumulative Distribution of Labor Market Concentration



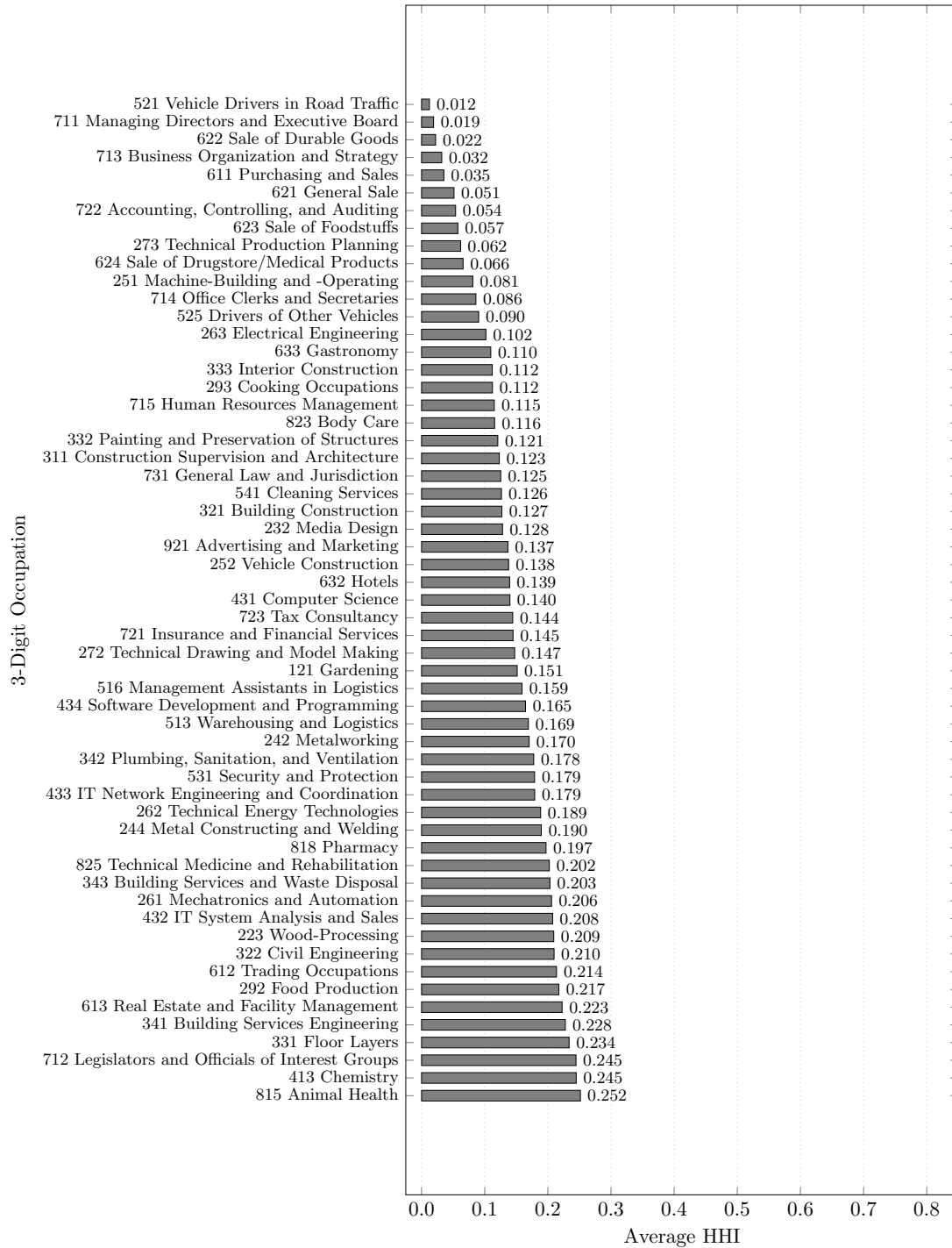
NOTE. — The figure illustrates cumulative distribution functions of labor market concentration in Germany for four different concentration indices: Herfindahl-Hirschman Index, 1-Firm Concentration Ratio, 3-Firm Concentration Ratio, and 5-Firm Concentration Ratio. Labor market concentration refers to hiring shares for pair-wise combinations of 3-digit KldB-2010 occupations (along with their requirement level) and commuting zones from Kosfeld and Werner (2012), and is tracked with annual frequency. Source: BEH, 2012-2023.

Figure B2: Selected Moments of Labor Market Concentration over Time



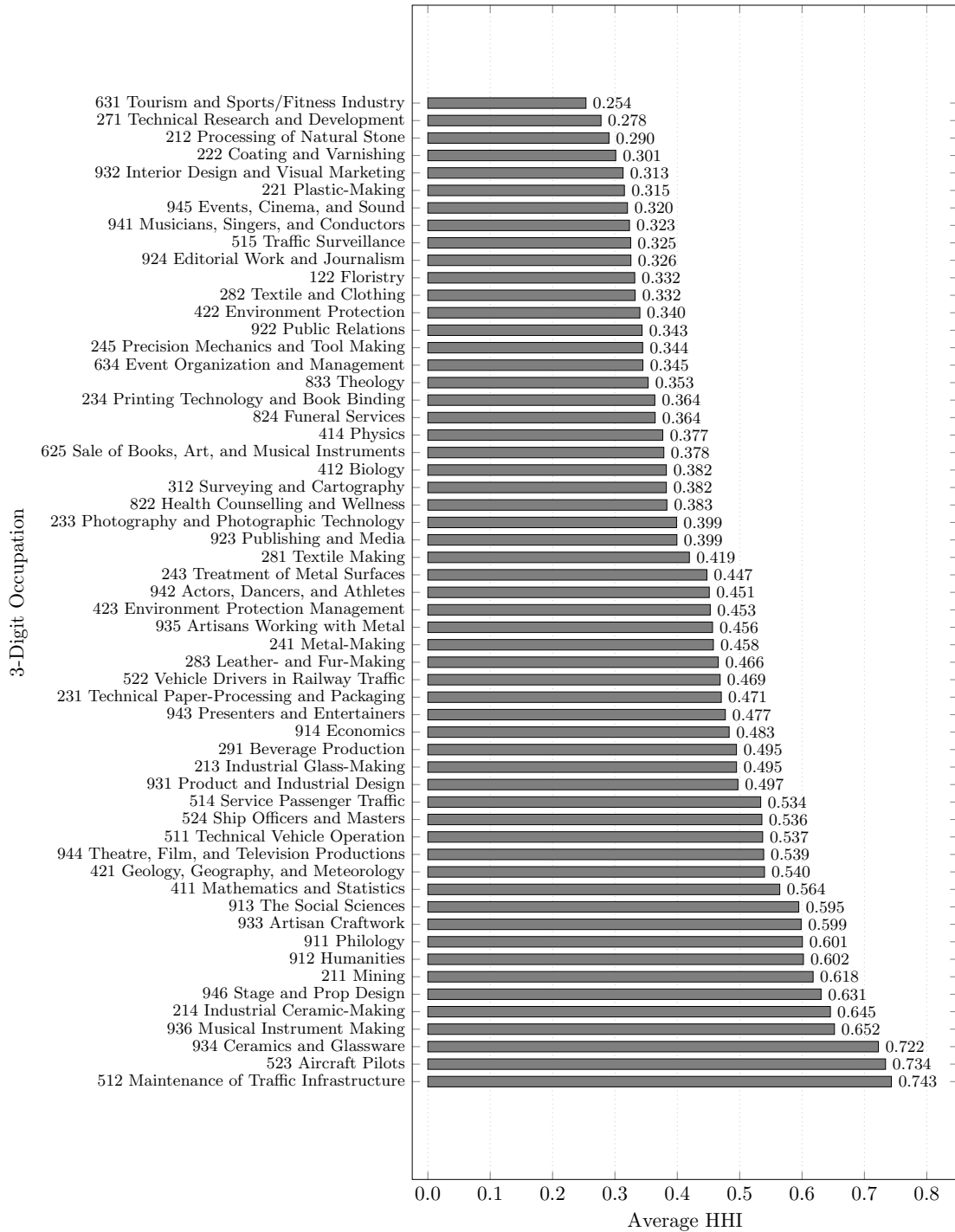
NOTE. — The figure reports means and selected percentiles of labor market concentration over time. Labor market concentration refers to HHI values (based on hiring shares) for pair-wise combinations of 3-digit KldB-2010 occupations (along with their requirement level) and commuting zones from Kosfeld and Werner (2012), and is tracked with annual frequency. HHI = Herfindahl-Hirschman Index. KldB = German Classification of Occupations. Source: BEH, 2012-2023.

Figure B3: Labor Market Concentration by 3-Digit Occupation



NOTE. — The figure displays average labor market concentration by 3-Digit KldB-10 occupations in Germany. Labor market concentration refers to HHI values (based on hiring shares) for pair-wise combinations of 3-digit KldB-2010 occupations (along with their requirement level) and commuting zones from Kosfeld and Werner (2012), and is tracked with annual frequency. HHI = Herfindahl-Hirschman Index. KldB = German Classification of Occupations. Source: BEH, 2012-2023.

Figure B3: Labor Market Concentration by 3-Digit Occupation (Cont.)



NOTE. — The figure displays average labor market concentration by 3-Digit KldB-10 occupations in Germany. Labor market concentration refers to HHI values (based on hiring shares) for pair-wise combinations of 3-digit KldB-2010 occupations (along with their requirement level) and commuting zones from Kosfeld and Werner (2012), and is tracked with annual frequency. HHI = Herfindahl-Hirschman Index. KldB = German Classification of Occupations. Source: BEH, 2012-2023.

## C Further Results on Labor Market Concentration by Industry

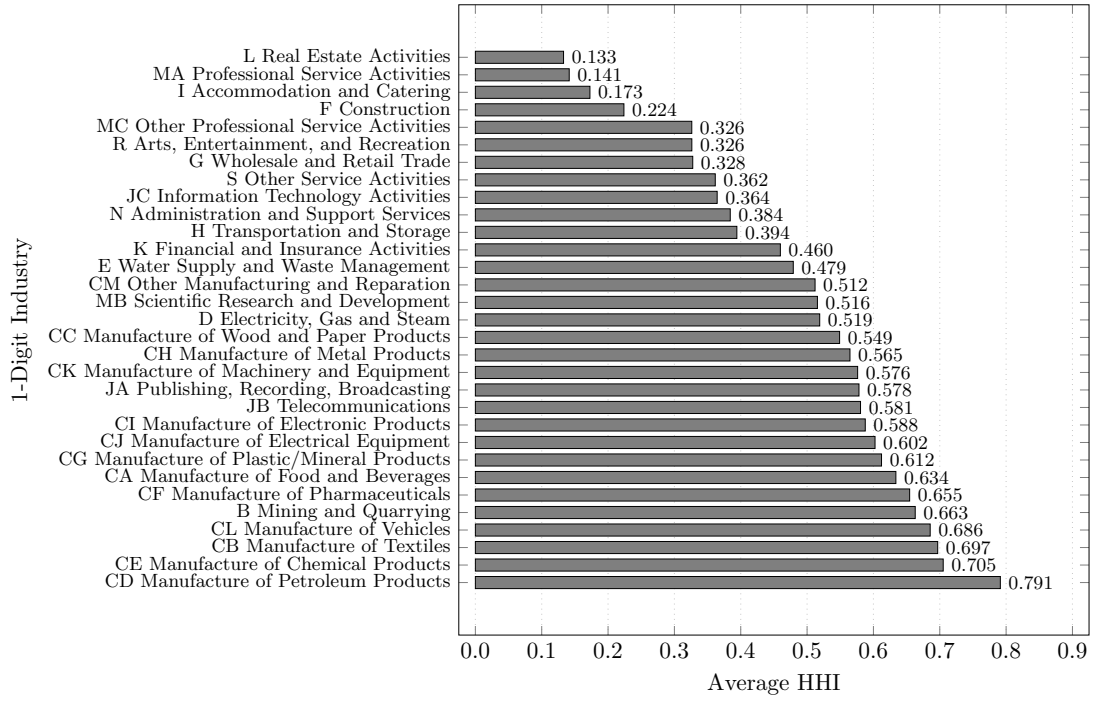
Table C1: Descriptive Statistics for Labor Market Concentration (in Terms of Industry)

	Mean	P10	P25	P50	P75	P90	Share (0.1-0.2)	Share (0.2-1.0)	Observations
<b>Baseline:</b>									
HHI, Hires, Commuting Zone									
4-Digit WZ-08 (Class)	0.435	0.048	0.128	0.333	0.716	1.000	0.149	0.649	608,070
<b>Alternative Industrial Dimension:</b>									
1-Digit WZ-08 (Section)	0.145	0.007	0.020	0.062	0.179	0.390	0.154	0.227	50,896
2-Digit WZ-08 (Division)	0.208	0.014	0.037	0.103	0.271	0.556	0.185	0.324	116,254
3-Digit WZ-08 (Group)	0.343	0.027	0.075	0.219	0.517	1.000	0.167	0.525	307,409
5-Digit WZ-08 (Sub-Class)	0.462	0.060	0.153	0.372	0.785	1.000	0.145	0.686	818,245
<b>Alternative Spatial Dimension:</b>									
NUTS-1 (Federal State)	0.243	0.012	0.037	0.123	0.338	0.709	0.169	0.379	93,323
NUTS-2 (Government Region)	0.298	0.020	0.060	0.179	0.440	0.909	0.174	0.470	213,751
NUTS-3 (District)	0.522	0.084	0.198	0.469	1.000	1.000	0.130	0.748	1,368,375
LAU (Municipality)	0.780	0.300	0.514	1.000	1.000	1.000	0.035	0.950	5,104,042
<b>Alternative Measure of Firm Size:</b>									
Employment	0.416	0.041	0.115	0.313	0.679	1.000	0.149	0.627	667,501
Wage Bill	0.465	0.061	0.156	0.384	0.793	1.000	0.141	0.693	667,501
<b>Alternative Concentration Index:</b>									
Inverse Number of Firms	0.342	0.017	0.053	0.200	0.500	1.000	0.139	0.505	608,070
1-Firm Concentration Ratio	0.523	0.122	0.241	0.480	0.833	1.000	0.123	0.803	608,070
3-Firm Concentration Ratio	0.742	0.277	0.510	0.857	1.000	1.000	0.044	0.944	608,070
5-Firm Concentration Ratio	0.816	0.380	0.665	1.000	1.000	1.000	0.023	0.973	608,070

NOTE. — The table displays descriptive statistics for labor market concentration in Germany. Labor markets refer to pair-wise combinations of industries and commuting zones, and are tracked with annual frequency. The baseline concentration refers to the market-level Herfindahl-Hirschman Index for hiring shares in yearly combinations of 4-digit WZ-2008 industries and commuting zones from Kosfeld and Werner (2012). HHI = Herfindahl-Hirschman Index. WZ = German Classification of Economic Activities. LAU = Local Administrative Units. NUTS = Statistical Nomenclature of Territorial Units. PX = Xth Percentile. Source: BEH, 2012-2023.

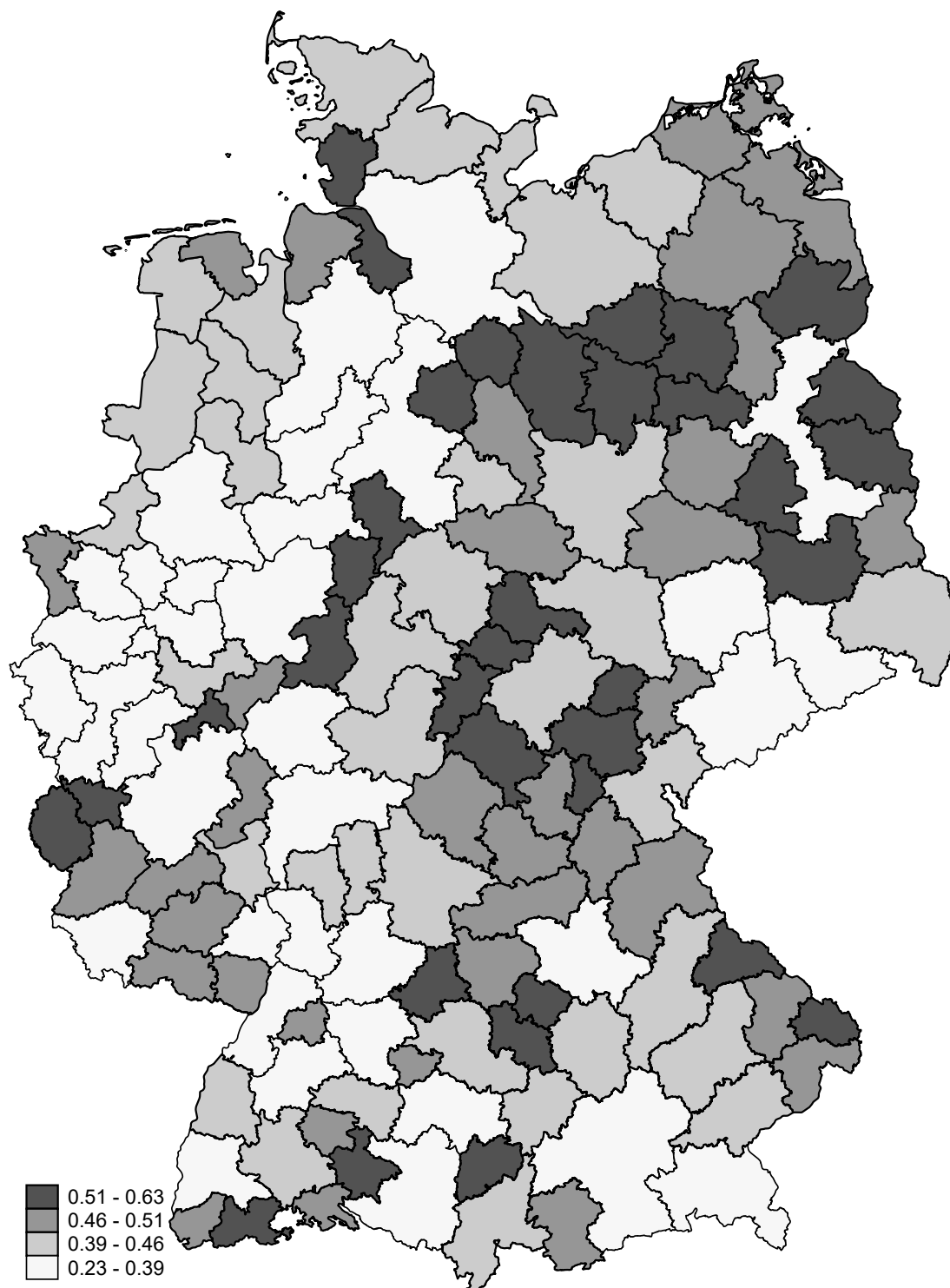


Figure C1: Labor Market Concentration by 1-Digit Industry



NOTE. — The figure displays average labor market concentration by 1-digit WZ-08 industries in Germany. Labor market concentration refers to HHI values (based on hiring shares) for pair-wise combinations of 4-digit WZ-2008 industries and commuting zones from Kosfeld and Werner (2012), and is tracked with annual frequency. HHI = Herfindahl-Hirschman Index. WZ = German Classification of Economic Activities. Source: BEH, 2012-2023.

Figure C2: Labor Market Concentration by Commuting Zone (in Terms of Industry)



NOTE. — The map displays average labor market concentration by commuting zones in Germany. Labor market concentration refers to HHI values (based on hires) for pair-wise combinations of 4-digit WZ-2008 industries and commuting zones from Kosfeld and Werner (2012), and is tracked with annual frequency. HHI = Herfindahl-Hirschman Index. WZ = German Classification of Economic Activities. Source: BEH, 2012-2023.

## References

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