

Spatial disparities in hiring problems: The role of firm characteristics, job features, and search channels

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Abstract

Against the backdrop of discussions about growing regional labour shortages, this study investigates spatial disparities in hiring problems using representative micro data on vacancies and establishments in Germany. Our results point to significant disparities that vary along the urban-rural hierarchy depending on indicator. While establishments in rural areas receive less suitable applications and more often abandon hiring plans, firms in cities more often report problems related to the applicants' qualification and wage expectations. Prevailing types of establishments and jobs explain an important part, but not all of the disparities. Evidence on concessions suggests, moreover, that employer responses to labour shortages differ depending on the location type. While establishments in urban areas are more likely to compromise on wages, concessions on qualification are more frequent outside big cities. However, rural establishments report problems related to applicants' insufficient qualifications less often. Heterogenous hiring problems indicate that there is need for place-sensitive policies rather than place-based policies that focus on specific locations.

Keywords: composition effects, hiring problems, labour shortage, urban-rural hierarchy

JEL classifications: R23, J63

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1 Introduction

In many regions of advanced economies, labour and skill shortages are among the most urgent policy concerns. They may have negative effects on the productivity of local firms and create barriers to exploiting economic opportunities arising from new technology or to meeting environmental targets (Green and Owen, 2003; Morris et al., 2020; OECD, 2024). While there is consensus that hiring problems have increased substantially over the past years and that spatial disparities in labour shortages are significant (Green and Owen, 2003; OECD, 2024), the evidence on the spatial pattern is less clear. Some studies emphasize shortages in rural areas (Watson et al., 2006; Hoyos and Green, 2011), often focusing on specific regions and sectors such as agriculture or health (Sharma et al., 2016; Jones et al., 2019; Nyström, 2021; Innerhofer et al., 2024). Other studies which compare hiring problems in urban and rural locations suggest either that in particular large urban areas suffer from above average labour shortages (Lee and Cowling, 2014; OECD, 2024) or that, in contrary, agglomeration effects mitigate the negative impact of labour and skill shortages through more efficient matching in the local labour market (Morris et al., 2020). Moreover, still little is known about the drivers of hiring problems in general (Groiss and Sondermann, 2024) and, more specifically, about the factors that explain spatial differences in shortages faced by firms.

This paper examines the spatial dimension of labour shortages based on data from a large representative establishment survey, which is combined with administrative data. The merged data provides detailed individual-level information on establishments, vacancies and hiring processes in Germany for the years 2015 to 2023. In order to find out the extent to which hiring problems differ systematically across location types along the urban-rural hierarchy, we first analyse how difficulties in filling vacancies depend on the establishment's location in an urban, semi-urban or rural area. We apply a broad set of indicators on hiring problems, including perceived staffing problems, the number of applicants, search duration, and cancelled hiring processes. In doing so, we assess disparities comprehensively and also consider different aspects of labour shortages.¹ Second, we provide evidence on the factors behind the spatial disparities and, particularly, on the role of composition effects. To do this, we analyse whether establishment characteristics, vacancy features, and search channels used to fill a vacancy correlate with the intensity of hiring problems. We examine to what extent spatial disparities in hiring problems between location types can be traced back to the composition of regions with regard to these influential factors and whether there remains an explanatory role for the spatial context establishments are located in. Finally, we also investigate whether establishments react differently to problems in filling a vacancy depending on their location. More specifically, we examine concessions on offered wages and required experience and skills.

Spatial disparities in recruiting difficulties between urban and rural areas are, at least in part, likely due to composition effects if hiring problems significantly correlate with establishment characteristics, vacancy features, or search channels. One reason is that the economic structure differs along the urban-rural

¹ We primarily use the term labour shortage to improve readability. However, our indicators refer to both labour *and* skill shortages.

hierarchy with regard to the types of establishments and jobs (Niebuhr et al., 2024). These differences may result in spatially varying skills shortages if, for instance, occupational or sectoral labour markets, that are nationwide particularly tight, are concentrated on a specific type of location. Furthermore, there is evidence that different types of establishments, which are located in different area types, tend to search for workers through different channels and that this also affects which kind of workers are attracted and how long hiring takes. Specifically, Carrillo-Tudela et al. (2023) find that job postings are particularly relevant to high-wage firms, while social networks or public employment agencies play a larger role for firms paying low wages. Dauth et al. (2022) in turn show that high-wage and low-wage establishments tend to be located in different locations along the urban-rural hierarchy. Taken together, the findings suggest that – due to compositional differences – typical search channels differ between location types which might also affect the matching between workers and employers.

Our results point to statistically significant disparities in labour shortages between location types. However, the magnitude of the difference is moderate for most indicators and the spatial pattern differs depending on the indicator considered. This suggests that it is the specificity of hiring problems that varies across location types rather than the overall intensity. Moreover, we find that hiring problems correlate with establishment characteristics, features of the advertised vacancies and applied search channels, giving rise to spatial disparities in shortages. Hence, these disparities are partly due to composition effects, because location types differ with respect to factors that influence the intensity of hiring problems. We also detect spatial differences in establishment behaviour in response to hiring problems. Some employers make concessions on wage claims, while others adjust skill requirements or even cancel the recruitment process. To some extent, this behaviour is also related to the spatial sorting of jobs and establishments and thus to composition effects.

Our paper contributes to a better understanding of firms' exposure to labour shortages and their reactions towards hiring problems in urban and rural areas. First, by considering several indicators relating to both unfilled labour demand and filled positions, we cover different dimensions of labour and skill shortages. We thereby pay attention to firms' broad interpretation of both quantitative and qualitative aspects of labour shortages (see e.g. Green et al., 1998). Many studies, in contrast, rely on only one indicator to measure such shortages (e.g., Haskel and Martin, 1993; Bellmann and Hübler, 2014; Healy et al., 2015; Nyström, 2021; Groiss and Sondermann, 2024) and, therefore, might not provide a complete picture of recruitment difficulties related to labour shortages, as pointed out by Green et al. (1998).

In a similar vein, Groiss and Sondermann (2024) discuss different aspects of labour shortages which cannot be examined using one specific indicator only. In particular, aggregate measures such as the vacancy rate or labour market tightness neglect important dimensions of hiring problems as they focus on unmet labour demand and labour shortages at the national, regional or industry level. Hiring problems might not become manifest in unfilled positions as reflected by vacancies, but also consist in concessions made by the firm when recruiting a worker or cancelling search. For example, using micro data for the UK, Green et al. (1998) show that an employers' signalling of skill shortage only partly overlaps with specific experiences of hard-to-fill vacancies. This suggests that it is important to pay attention to various

aspects of hiring problems. Using single indicators referring to particular dimensions of hiring problems might also explain contradictory findings on spatial disparities in the literature. Considering several indicators which relate to different aspects of labour and skill shortages, we show that the spatial pattern of disparities in fact varies depending on the applied measure of hiring problems.

Second, relying on a large, representative data set on firms' labour demand, the Job Vacancy Survey (JVS) of the Institute for Employment Research (IAB), enables us not only to provide detailed evidence on spatial disparities, but also to generalize inference. Overall, the JVS provides more in-depth insights into labour and skill shortages than most other job vacancy surveys and statistics (Bossler et al., 2020). Representative studies often offer little detail on regional hiring problems as they tend to rely on one aggregate indicator (e.g. OECD, 2024). Moreover, we avoid drawbacks of in-depth (case) studies that often utilize small samples or specific information on selected sectors or regions and therefore lack generalization (Hoyos and Green, 2011; Lee and Cowling, 2014; Nyström, 2021). Another advantage of the JVS – in addition to its representativeness and the extensive information it provides on search and recruitment processes – is that it contains detailed information about the locations of the surveyed establishments at the municipal level. Based on this, we group vacancies and establishments into urban, semi-urban and rural areas applying the degree of urbanisation (DEGURBA) classification from DG REGIO, the Directorate-General for Regional and Urban Policy of the European Commission, and Eurostat. This enables us to take the establishments' locations into account precisely and differentiate on a small scale.

Third, our analysis also adds to the small strand of research that makes use of micro-data to investigate the causes of hiring problems (Groiss and Sondermann, 2024). Considering the role of the determinants of labour shortages for spatial disparities, we provide evidence on an issue that has not received much attention in this literature. Lee and Cowling (2014) apply a similar approach to investigate spatial disparities in perceptions of, inter alia, recruiting problems in the UK and examine whether they are related to firm characteristics. However, considering more generally barriers to firm growth, the study does not provide much detail on labour shortages. Their results indicate that firms located in urban areas are more concerned about recruiting issues than rural firms, which is due to firm characteristics. Groiss and Sondermann (2024) find that labour shortages in EU areas are primarily related to structural factors that change slowly over time. While firm characteristics are important predictors of hiring problems according to their results, the probability that firms report problems also increases if there is a local shortage of labour supply and relatively low unemployment. This suggests that both firm characteristics and the spatial context seem to play a role.

Using information on filled vacancies, we investigate whether establishment characteristics as well as job features and search channels correlate with the intensity of hiring problems. Previous studies tend to focus on the role of firm characteristics (see e.g. Lee and Cowling, 2014; Groiss and Sondermann, 2024). Applying a broad range of indicators for hiring problems, we make use of different microeconomic estimation techniques depending on the respective measure for labour shortage. They include logistic and negative binomial regressions as well as survival analysis. With these regressions, we examine spatial disparities in hiring problems and in the extent to which these differences can be attributed to

composition effects with respect to the recruiting establishment, the type of job, and the applied search channels.

A fourth contribution relates to the policy dimension of regional labour and skill shortages. Understanding the extent to which spatial differences in recruitment problems are related to the attributes of establishments, jobs, and search channels, or to spatial factors such as the regional labour supply, is important for designing policies to counteract hiring problems. Some recent studies advocate place-based approaches to address regional labour and skill shortages (Corradini et al., 2023; OECD, 2024). This assumes that firms differ in the obstacles they face depending on their location (Lee and Cowling, 2014). However, measures focusing on specific types of local labour markets are probably less effective than policies which aim at directly supporting particular types of firms if more severe hiring problems are primarily due to characteristics of establishments that prevail in these areas (see also Lee and Cowling, 2014). A place-based approach, in contrast, might be preferable if firms face hiring problems first of all because of the specificities of their location.

Beyond the question of whether place-based policies represent an adequate approach to address local labour and skill shortages, it is also important to know how firms respond to hiring problems and whether these responses are affected by the spatial context. Lee and Cowling (2014) argue that firms likely adapt their strategies to reflect the (dis)advantages of their location. While subsidizing job-related training might be a good option if firms tend to adjust skill requirements in response to local skill shortage, cancelled hiring processes likely call for other policies. However, previous studies on local hiring problems tend to pay little attention to spatial differences in adaptation strategies of employers (e.g., Green and Owen, 2003; Nyström, 2021). Based on information available in the JVS, we provide novel information on whether employers' reactions towards local labour and skill shortages differ across space and on the factors behind these disparities.

The remainder of the paper is structured as follows. In section 2, we describe the data used in our analysis and how location types are defined. Section 3 gives the details of our microeconomic analyses, in section 4 we discuss the estimation results, and in section 5 we set out our conclusions.

2 Data

2.1 Information on vacancies and establishments

Our main data source is the Job Vacancy Survey (JVS) of the Institute for Employment Research (IAB). It is a quarterly survey that is representative for the entire unfilled labour demand in Germany. It offers detailed description of vacancies, employers' search and both successful and unsuccessful recruitment efforts (for details see Bossler et al., 2020 and Diegmann et al., 2025). As such, the JVS provides much more accurate and detailed information about establishments' search for employees than official statistics. The vacancies recorded by the Federal Employment Agency, for example, cover only a non-

representative sample of all vacancies in Germany and provide little detail on the position to be filled and the hiring process. We use information from the JVS of the fourth quarter of each year in the period 2015-2023.²

For additional information on the surveyed establishments, we merge the JVS with data from the Establishment History Panel (EHP) via a unique establishment identifier. The EHP is also provided by the IAB and contains administrative information on all establishments in Germany with at least one employee liable to social security contributions as of June 30 (see Ganzer et al., 2024). It reports not only the establishment's economic sector and location, but also the number of employees by occupation and qualification as well as wages of full-time employees. To avoid endogeneity problems, we retrieve information from the EHP that relates to the year before an establishment was surveyed in the JVS. For 82 percent of the establishments in the JVS, further information from the EHP can be matched. The merged data comprises a total of 123,029 establishments, 84,763 of which stated that they filled vacancies within the previous 12 months.

To analyse the problems establishments face when hiring, we use the extensive information in the merged data on establishments, vacancies and the search for workers. Because the dependent and explanatory variables contain missing values, the regressions are not based on all the observations in the merged data. The final samples comprise 69,306 establishment-year observations and 50,910 successfully filled vacancies, respectively.

As main dependent variables, we use four indicators. Our first indicator covers very general aspects of labour shortages and shows whether an establishment *reported difficulties during the last hire* and, if yes, what type of difficulties. The second indicator is the *number of suitable applicants* for the filled position, and the third indicator quantifies the *length of the hiring process*. To capture that a lack of suitable applicants might result in a stopped search, we define the *cancellation rate* as the fourth indicator. It relates the number of stopped searches to all recruitment processes of the establishment, i.e. the sum of stopped searches and successfully filled positions. The first three indicators centre on the recruitment process with respect to the last successful hire, while the last indicator refers to all recruitment processes of the establishment within the last 12 months.

The JVS also provides information on whether concessions were made when filling positions, which can be a strategy to avoid a failure of the hiring process. In this regard, we examine three additional indicators. They provide insights on whether the originally intended job specification of the vacant position was adjusted upwards in terms of offered wages or downwards in terms of required qualification and experience. Detailed information on all indicators and all other variables included in our analyses is provided in Tables A1 and A2 in the Online Appendix. Summary statistics are given in Tables A3 and A4.

² The survey conducted in the fourth quarter constitutes the main survey that consists of several modules. One module relates to the last new hire and the last case of a failed recruitment effort, and it collects detailed information on the search process and the search channels adopted by the employers. Except for minor changes, both the main questionnaire and the last module are stable over time (Bossler et al., 2020).

2.2 Delineation of location types

To examine spatial differences in hiring problems along the urban-rural hierarchy, we use small-scale information on establishment locations available at the municipality level in the JVS. We distinguish locations in (i) cities, (ii) towns and suburbs, and (iii) rural areas according to the degree of urbanisation (DEGURBA) from DG REGIO and Eurostat. The typology classifies all 10,990 German municipalities (as of December 31, 2022) based on a combination of geographical contiguity and population density of 1 km² grid cells (see Section A1.3 in the Online Appendix for details).

Distinguishing between types of locations based on small-scale information has the advantage over large-scale regional delineations in that the former allows firms to be considered in relation to their close spatial environment. Manning and Petrongolo (2017) show, based on data for the UK, that the likelihood of job applications decreases sharply with increasing distance. According to their results, a job 5 km away is preferred to a local job in less than one out of five cases. High costs of distance are also reflected in low commuting distances. In Germany, the first quartile of commuting distances is around 3 km by road and the median is 10.5 km (Dauth and Haller, 2018). This means individual commuting distances are often significantly smaller than labour market regions, which combine territorial units linked by commuter networks.³ From a firm's perspective, a rapid decline in the attractiveness of a job due to distance likely implies that the chance of filling a position depends primarily on how many workers live in the immediate vicinity. Therefore, it seems plausible to classify establishment sites based on small-scale data. Another advantage of considering the DEGURBA is that the regional classification does not depend on the delimitation of large administrative territorial units such as NUTS 3 regions which cause sharp spatial discontinuities.

Figure A1 in the Online Appendix depicts the DEGURBA for Germany and also shows a classification of 223 labour market regions that we use for robustness checks. While the agglomeration centres in Germany are assigned to the same category in both typologies, the classification of the surrounding areas of these centres often differs. Several municipalities that are classified as town and suburb or rural area based on the degree of urbanisation are considered urban at the level of labour market regions. Conversely, in labour market regions classified as rural there are also municipalities that are considered cities at the more granular level to which the degree of urbanisation refers.

3 Estimation strategy

As described in section 2.1, we analyse spatial disparities in hiring problems based on different dependent variables y_{it} . The index i refers to either a filled position or an establishment, depending on the variable considered. t is the year of observation. For each indicator of labour shortage, we estimate regressions

³ The first quartile and the median of the size of 223 German labour market regions are 866 km² and 1300 km² respectively, which corresponds to radii of 16.6 km and 20.3 km if the regions were circular (own calculations).

which can generally be described as follows:

$$y_{it} = \alpha + x_{it}\beta + \rho_{r(i)} + \theta_t + \gamma I(i \in East) + \varepsilon_{it}. \quad (1)$$

x_{it} is a vector of the characteristics of the establishment, the vacancy, and the recruitment process with the parameter vector β . Detailed information on the three groups of variables is provided in Table A2 in the Online Appendix. $\rho_{r(i)}$ denotes a fixed effect for the location type r in which observation i is located. This is the parameter we are particularly interested in. It captures systematic differences in recruitment problems between the three different types of location described in section 2.2. θ_t is a year fixed effect, and parameter γ refers to the indicator function $I(i \in East)$ capturing whether observation i is located in East or West Germany. We include this term to control for long-lasting labour market differences related to the division of Germany prior to 1990, among other factors. ε_{it} is an error term.

Depending on the variable y_{it} under consideration, we estimate the parameters of Equation (1) using different microeconomic methods. Specifically, we estimate logit models for binary responses (difficulties during the last hire yes/no) and negative binomial regression models for count data (number of suitable applicants). Our default specification for the latter assumes that each vacancy has the same length of observation time. However, we also estimate specifications including the planned search duration as exposure time. Thereby we address a significant variation of the (planned) search time which indicates that the length of the search process differs across vacancies. Cox models for time-to-event data are used to analyse the length of the hiring process, i.e. the time it takes to fill a vacancy. As the information on search duration comes from filled vacancies only, there are no censored data in our case. Finally, fractional logit models used to examine the cancellation rate account for the fact that this dependent variable falls into the interval $[0,1]$.⁴

For each dependent variable, we consider four specifications. First, we estimate a base model that includes only the fixed effects for the location type as well as the indicator for East Germany and year fixed effects. The results are presented in section 4.1. Second, we add characteristics of the establishment. Third, we consider characteristics of the vacant position in addition, and fourth, we also include information on the recruitment process. The baseline estimates provide information on the extent to which recruitment problems vary between location types, controlling only for differences between East and West Germany and between years. Changes in location type fixed effects induced by the inclusion of the different sets of control variables indicate the extent to which spatial differences in y_{it} are due to composition effects. These results are discussed in section 4.2.

The last part of our empirical analysis refers to spatial differences in the adaptation behaviour of establishments (section 4.3). To study heterogeneity in concessions with respect to wages, qualifications and work experience between location types, we proceed as described above for the analysis of staffing problems and estimate the parameters of Equation (1) employing logistic regressions. The dependent variables y_{it} are binary indicators as described in Table A1 in the Online Appendix.

⁴ For a specific description of the different regression models please refer to, e.g., Wooldridge (2010) or Greene (2019) or to the Stata manuals logit, nbreg, stcox, and fracreg.

In order to examine the robustness of our findings, we conduct a number of additional analyses. First, we use a classification of labour market regions instead of degrees of urbanisation to define the location type. Second, we test whether reducing the original sample due to missing values of explanatory variables reveals the same unconditional spatial disparities in hiring problems as estimates of the base model based on the largest possible sample per dependent variable. Third, since the search channels used by the establishments might be influenced by hiring problems that they experience, we omit them as control variables in some specifications to check whether the potential endogeneity affects our results. Fourth, we run regressions where potential outliers are accounted for by excluding all observations belonging to the lowest and highest 1st percentiles of all metric variables used in the analysis.

4 Results

4.1 Regional disparities in hiring problems

In this subsection, we discuss the results of the base specification which indicates whether hiring problems differ significantly across cities, towns and suburbs, and rural areas, unconditional on establishment characteristics, job features, and search channels. Hence, the models only include dummies for the location types and for East Germany as well as year fixed effects. The first three indicators of hiring problems discussed in the following relate to the last successful hire in the past 12 months. The fourth indicator considers both successful and unsuccessful job placements.

We start by using the most general measure of labour shortages that indicates whether the establishment reported difficulties during the last hire. Figure 1 shows the coefficients of the base model together with their 95% confidence intervals. The results for the types of location suggest that establishments in towns and suburbs as well as in rural areas face slightly less hiring problems than firms in cities that constitute the reference category. The predicted probability that an establishment located in a West German city reports a problem is 0.460 in 2022, the year when labour shortages according to this indicator were highest in the period under consideration.⁵ The likelihood of reporting problems is 0.446 (0.448) instead if the establishment is located in a town or suburb (rural area). Thus, while statistically significant, spatial disparities lack economic significance. This also applies to the differences between East and West Germany which amount to 2 percentage points.

The results for the year fixed effects point to a steadily increasing probability of reporting hiring problems in Germany, in line with evidence on labour shortages which have risen substantially in different countries during the last years (OECD, 2024). Compared to the spatial disparities discussed above, these changes are also economically significant. The probability of hiring problems in the reference category increased by 14 percentage points ($= [0.460 - 1/(1 + \exp(0.742))] \times 100$) between 2015 and 2022, only interrupted by the labour market shock caused by the Covid-19 pandemic in 2020. Moreover, labour

⁵ The predicted probability is given by $0.460 = 1/(1 + \exp(0.742 - 0.581))$, with -0.742 being the regression constant of the logit model and 0.581 the year fixed effect for 2022.

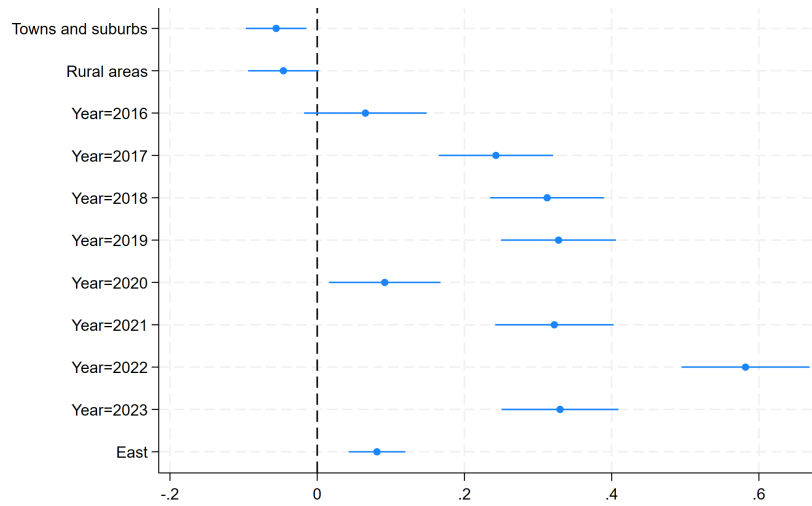


Figure 1: Regional disparities in difficulties during the last hire

Notes: The figure illustrates the estimated coefficients of a logit model with a binary variable indicating that the establishment reported problems when filling the vacancy as dependent variable. Reference categories are urban areas, the year 2015 and West Germany, respectively.

Source: Own calculations based on IAB-JVS.

shortages returned to the 2021 level in 2023, probably due to persistent economic weakness of the German economy and effects of the energy crisis.

In the JVS, the establishments also provide more detailed information on the type of difficulties that they faced when filling the vacancy. The estimates of the corresponding base models indicate that the less frequent problems outside larger cities are due to the fact that employers in locations of lower density tend to report less often difficulties concerning qualifications and wage expectations of applicants (see Figures A2a and A2b in the Online Appendix). Corresponding spatial differences, ranging between 2.3 and 4.1 percentage points in 2022, are also slightly larger in size than disparities in difficulties in general (1.1 to 1.4 percentage points). Furthermore, establishments in rural areas experience slightly more often that applicants refused working conditions of the job (Figure A2c in the Online Appendix). In contrast, locations types do not differ statistically significantly when it comes to the problem of too few applicants (Figure A2d in the Appendix).

Turning towards the second main indicator for labour shortages, we examine regional differences in the number of suitable applicants. Figure 2 summarizes the results of the corresponding base model.⁶ The estimates suggest that establishments outside larger cities receive significantly less suitable applications. The coefficients give the difference in the log of the expected number of suitable applicants relative to the reference category. Since the number of suitable applicants may also depend in part on the duration of the search, we include the logarithmic planned search time as exposure variable in an additional specification. Without this exposure variable, the number of suitable applicants declines by 37% [=

⁶ The estimate of the dispersion parameter α is positive and differs significantly from zero, indicating overdispersion and appropriateness of the negative binomial model.

$(1 - \exp(-0.467))100\%$] as we move from a city to a rural location (see Figure 2a). The decline amounts to 21% for towns and suburbs. Taking into account the search time slightly increases the difference for rural areas to 44%, while the difference between towns and suburbs and the reference location is not statistically significant anymore (see Figure 2b). Hence, the lower number of suitable applicants that we observe for the latter relative to cities in the standard model is due to a shorter search time, which is in line with the findings for the length of the hiring process below. Although the number of applications is much lower in rural locations, employers do not seem to perceive this as a more severe problem than firms in denser areas, as indicated by the results discussed above.

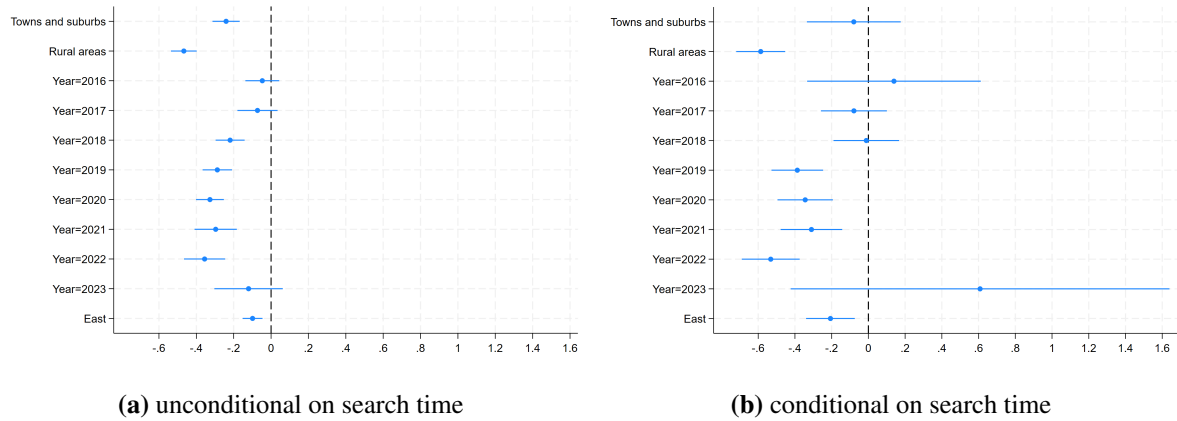


Figure 2: Regional disparities in the number of suitable applicants

Notes: These figures illustrate the estimated coefficients of a negative binomial regression model with the number of suitable applicants as the dependent variable. Reference categories are urban areas, the year 2015 and West Germany, respectively. While panel (a) refers to a specification that does not take into account the planned search time as ‘exposure’, panel (b) does. Source: Own calculations based on IAB-JVS.

The results of a Cox proportional hazards model for the length of the hiring process that constitutes our third measure are summarized in Figure 3. The 95% confidence intervals indicate that only the search times in towns and suburbs differ significantly from those in cities. The negative coefficient estimate points to a lower probability of filling an open position, i.e. the hiring process takes longer in towns and suburbs. The hazard rate of filling a vacancy is 2.4% ($[1 - \exp(0.023 \times 1)] \times 100$) lower compared to cities. In contrast, there is no statistically significant difference in the average length of the hiring process between rural areas and cities. Disparities between East and West Germany are stronger, with vacancies in East German locations showing a 9.5% lower hazard rate than establishments in West Germany. Moreover, the time effects indicate that recruiting takes on average more and more time in the German labour market which is in line with evidence on rising recruitment problems.

The three indicators of hiring problems discussed so far consider vacancies which are successfully filled. However, persistent problems with filling a vacancy might in the end lead firms to stop the search. This outcome is rarely examined in the literature due to data limitations. Figure 4 shows the baseline estimates of a fractional logit model for the establishments’ cancellation rate that represents our fourth indicator of labour shortages. The average cancellation rate predicted by the model for an establishment in a West German city is 9.2% in 2022, which is the year marked by the highest probability of stopping recruitment

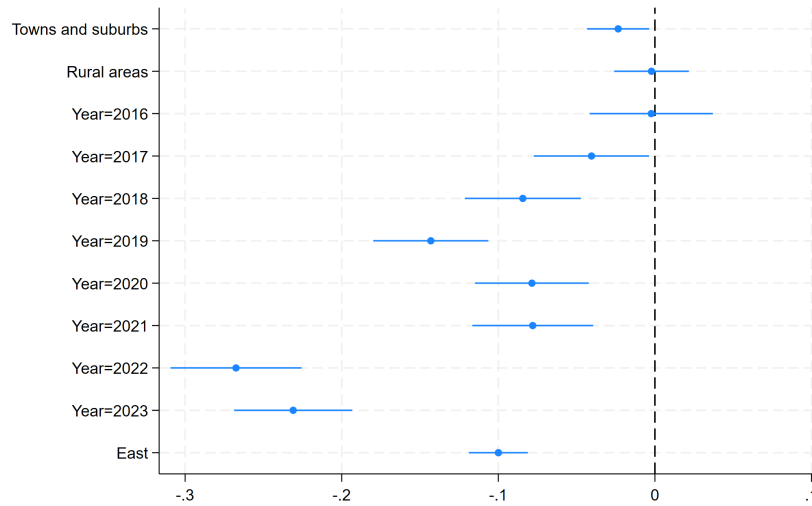


Figure 3: Regional disparities in the length of the hiring process

Notes: The figure illustrates the estimated coefficients of a Cox proportional hazards model with the length of the recruitment process as the dependent variable. Reference categories are urban areas, the year 2015 and West Germany, respectively.
Source: Own calculations based on IAB-JVS.

processes in the period under consideration.⁷ The probabilities in towns and suburbs (10.0%) as well as in rural areas (10.9%) are significantly higher. As cancellations are also more frequent in East Germany, the gap to the reference is largest for establishments in rural areas in the Eastern part of the country (12.0%). In line with the results for the first and third indicator, the time effects indicate increasing cancellation rates until 2022.

Altogether, the base specifications point to spatial disparities in hiring problems which tend to be moderate, however. The differences between location types along the urban-rural hierarchy vary depending on the indicator under consideration. This suggests that labour shortages manifest themselves in different ways and that considering several indicators gives a more comprehensive picture of spatial disparities than focusing on just one. The cancellation rate that refers to all searches of the establishments within the last 12 months and that is probably indicative of very severe problems shows lowest rates in cities and highest rates in rural locations. Consistently, the number of suitable applicants among successful recruitments is lowest in rural areas and highest in urban areas. In cities, hiring problems appear to be of a somewhat different nature. Although the number of applicants is higher there, establishments more often report problems, primarily because applicants were not sufficiently qualified or rejected the salary offered. As regards the time it takes to fill a vacancy, we observe only small spatial differences.

⁷ The predicted rate is given by $0.092 = 1 / (1 + \exp(2.695 - 0.410))$, with -2.695 being the regression constant of the logit model and 0.410 the year fixed effect for 2022.

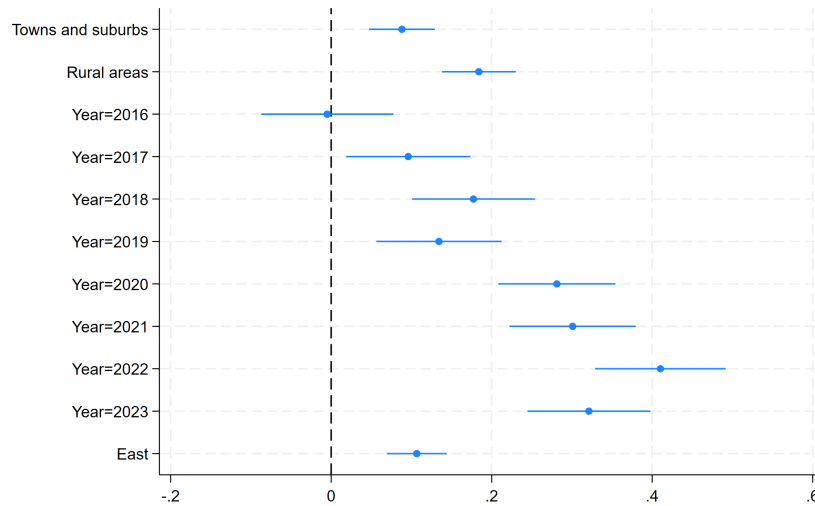


Figure 4: Regional disparities in cancellation rates

Notes: The figure illustrates the estimated coefficients of a fractional logit model with the cancelation rate as the dependent variable. Reference categories are urban areas, the year 2015 and West Germany, respectively.
Source: Own calculations based on IAB-JVS.

4.2 Role of establishment characteristics, job features, and search channels

We extend the base model to investigate whether the spatial disparities documented in section 4.1 are (partly) due to differences in the composition of location types by successively adding establishment characteristics, vacancy features, and information on the search channels used to fill the vacancy. Table 1 summarizes the results of the extended models for the four indicators of hiring problems. Column (1) shows the results of the base model discussed in section 4.1 as a reference. We add establishment variables in column (2) and job features in column (3). The full model in column (4) also includes information on the search channels and on the planned search duration. Since we now report odds ratios and hazard ratios (unlike in section 4.1), spatial disparities decline as the ratios converge to one and vice versa. Table A6 in the Online Appendix shows the results for all explanatory variables of the full model.

The results in panel A of Table 1 indicate that spatial disparities in reporting difficulties during the last recruitment process tend to increase rather than decrease when we control for characteristics of the job and the search. Thus, these differences in composition tend to counteract rather than cause disparities between location types. In other words, for the types of jobs and search processes that are typically overrepresented outside cities it is more likely that establishments report hiring problems than for the types which prevail in urban areas. The type of establishment, in contrast, does not seem to matter.

Supplementary results in panel C in Table A5 in the Online Appendix for specific recruitment difficulties indicate that the unfavourable composition of jobs in rural areas is at least partly attributable to applicants refusing working conditions. This is more often reported in rural areas, while there are no disparities be-

Table 1: Spatial differences in hiring problems (un-)conditional on establishment, job and search characteristics

	(1)	(2)	(3)	(4)
A Difficulties during the last hire (N = 50,636)				
Towns and suburbs	0.946*** (0.020)	0.945** (0.022)	0.934*** (0.022)	0.904*** (0.023)
Rural areas	0.956* (0.023)	0.950* (0.026)	0.933** (0.027)	0.902*** (0.028)
Log pseudolikelihood	-33394.803	-32388.681	-30866.759	-28164.918
B Number of suitable applicants (N = 45,499)				
Towns and suburbs	0.786*** (0.029)	0.910*** (0.023)	0.924*** (0.021)	0.922*** (0.020)
Rural areas	0.627*** (0.022)	0.816*** (0.021)	0.837*** (0.019)	0.843*** (0.018)
Log pseudolikelihood	-107500.62	-102588.21	-101242	-99442.198
C Search duration (N = 48,207)				
Towns and suburbs	0.977** (0.010)	0.977** (0.011)	0.978** (0.011)	0.993 (0.013)
Rural areas	0.998 (0.012)	0.992 (0.013)	0.989 (0.014)	1.005 (0.016)
Log pseudolikelihood	-471980.13	-471625.09	-466325.9	-464638.57
D Cancellation rate (N = 69,306)				
Towns and suburbs	1.092*** (0.023)	1.001 (0.022)		
Rural areas	1.202*** (0.028)	1.019 (0.027)		
Log pseudolikelihood	-19989.71	-18988.34		
Base model variables	yes	yes	yes	yes
Establishment variables	no	yes	yes	yes
Job variables	no	no	yes	yes
Search variables	no	no	no	yes

Notes: The table displays regression results for four indicators of hiring problems. ***, ** and * indicate significance at the 1, 5 and 10 percent level. Region types according to the degree of urbanisation (DEGURBA) from DG REGIO and Eurostat. The reference category is urban areas. Panel A reports odds ratios from a logit model. Panel B summarizes the estimated incidence rate ratios from negative binomial regressions. Panel C contains hazard ratios from a cox model and Panel D shows the odds ratio results of a fractional logit model. A list of control variables considered can be found in Table A2 in the Online Appendix. Source: Own calculations based on IAB-JVS and EHP.

tween towns and suburbs and cities. However, once we control for establishment characteristics, job features and search channels, establishments located outside cities report this problem less frequently than establishments in urban locations. This suggests that outside cities there are more establishments and jobs which involve unattractive working conditions relative to urban areas. Hence, compositional differences are counteracting the lower frequency of reports about staffing problems outside cities, respectively. Less frequent problems in towns and suburbs and rural areas (see column (4)) are due to other factors.

With regard to insufficiently qualified applicants and applicants refusing wage offers (see panel A and B in Table A5 in the Online Appendix), spatial differences tend to be largely unchanged or slightly reduced when we control for composition. These two types of difficulties remain significantly larger in urban areas than in the other two location types conditional on composition. There is only weak evidence on above average problems caused by too few applicants in rural areas (panel D). Corresponding spatial differences are primarily due to the type of establishments and characteristics of jobs. Once the composition is considered, these problems tend to be slightly less frequent outside cities.

The latter findings are partly confirmed by results in panel B of Table 1 for the number of suitable applicants. More than half of the gap between cities and smaller locations seems to be due to the types of establishments that prevail in the respective location type. Job features further reduce the disparities, while different search channels are of minor importance. Altogether, the differences between location types decline to about one third (incidence rate ratio increases from 0.627 to 0.843) if composition is accounted for, leaving room for effects of unobservable factors or of the regional context.⁸

The role of composition effects for the search duration shown in panel C of Table 1 is different again, as neither establishment nor job features affect the disparities between cities and the other two location types. However, disparities disappear once we consider the used search channels (column (4)). Evidently, systematic differences in search behaviour across location types seem to cause the minor differences in the hazard rate of filling a vacancy that we observe.

Finally, we examine the role of composition for the cancellation rate in panel D of Table 1. We can only investigate the importance of establishment characteristics here because the indicator is measured at the establishment level. The estimates in column (2) indicate that spatial disparities in the share of stopped search processes can be traced back to establishment factors. We observe a higher probability of unsuccessful recruiting outside large cities because certain establishment types such as very small firms and construction companies that cancel hiring more often (see Table A6 in the Online Appendix) are overrepresented in smaller locations.

All in all, the results point to an important role of composition effects. The differences between location types in terms of the number of suitable applicants, search duration and cancellation rate decline substantially when we control for characteristics of the establishments, jobs, and search channels. With regard

⁸ The results in panel B refer to a specification without considering the search duration as exposure. However, we observe a similar pattern for the disparities between cities and rural areas when we control for the search duration in the analysis of the number of suitable applicants. Corresponding results are available upon request.

to the latter two indicators, statistically significant disparities vanish once we take composition into account. Spatial differences in the number of suitable applicants and the frequency of search cancellations appear to be particularly related to establishment characteristics. Different search channels contribute to disparities in search duration. Only in the case of our general indicator on difficulties in filling the vacant position do composition effects tend to *reduce* spatial disparities.

The results of the robustness checks are consistent with these results. This applies to both the patterns of spatial disparities (see section 4.1) and the role of composition effects. More precisely, findings at the level of labour market regions are qualitatively very similar to the evidence for the degrees of urbanisation (see Table A8 in the Online Appendix). Interestingly, the model fit tends to be higher for the latter, suggesting that the smaller spatial scale might be more appropriate. The discussed results for the base models refer to the same restricted sample as the extended full models where the sample is reduced due to missing values of explanatory variables. The reduction of the sample has no significant effect on the results for the base models: the estimates of the base models obtained with the largest possible sample reveal only minor differences (compare results in Column (1) of Table 1 with results in Table A9). Furthermore, omitting the ways of searching as control variables results in minor changes of the location type effects (see Table A10). Last, excluding the observations belonging to the lowest and highest 1st percentiles of all metric variables gives rise to slightly larger spatial disparities for reported difficulties during the last hire, while changes for all other outcomes are negligible (Table A11).

4.3 Spatial differences in adaptation behaviour

Although establishments in cities report slightly more often problems when filling a vacancy, they less frequently stop the hiring process than employers outside cities. The latter is due to the types of establishments that prevail in different location types. These findings might indicate that types of establishments often located in urban areas have more successfully developed strategies to cope with hiring problems than establishments located elsewhere. More generally, firms might adapt their recruitment behaviour to the respective local labour market conditions to avoid a failure of the hiring process. In the following, we examine this adaptation behaviour in more detail.

The results in Panel A of Table 2 show that adaptation behaviour of establishments in response to hiring problems in fact differs systematically across location types (column (1)).⁹ First of all, wage concessions are more prevalent in cities, which is in line with spatial disparities in hiring problems and indicates more disagreement on the wage level in urban locations (see Figure A2b and Figure A3a in the Online Appendix). The odds of renegotiating the wage are 8.1% (7.6%) lower in rural areas (towns and suburbs) than the odds in cities according to our estimates. An explanation might be the higher wage setting power of employers outside dense markets as documented by Hirsch et al. (2020). Establishments in smaller locations, in contrast, more often accept a mismatch regarding qualification and experience of the applicant (Panel B and C in Table 2), although they less often report that applicants were insuffi-

⁹ The results for the base models in Column (1) of Table 2 refer to the reduced sample that provides information on all control variables considered in the full model. We obtain very similar results for the base models using the full sample (see Table A7).

ciently qualified (see Figures A2a, A3b and A3c in the Online Appendix). The odds of accepting an applicant with lower qualification or less experience in smaller locations exceeds the odds in cities by between 9.7% and 32.3%, with the probability of concessions being always higher in rural areas. The inconsistency between the spatial patterns of reporting problems and responding to problems might point to potential differences in the perception of hiring problems in urban and rural locations. For example, a less than perfect match might be perceived by rural establishments rather as a common feature of recruiting than as a problem. As small rural labour markets likely allow for less specialization of workers and jobs (see e.g. Duranton and Puga, 2004), concessions might be feasible, whereas mismatch poses more of a problem for highly specialized urban jobs.

Table 2: Spatial differences in adaptation behaviour (un-)conditional on establishment, job and search characteristics

	(1)	(2)	(3)	(4)
A Concessions wage (N = 50,712)				
Towns and suburbs	0.924*** (0.025)	0.924*** (0.027)	0.957 (0.029)	0.948* (0.030)
Rural areas	0.920*** (0.029)	0.917** (0.033)	0.953 (0.036)	0.938* (0.036)
B Concessions qualification (N = 50,723)				
Towns and suburbs	1.168*** (0.039)	1.098*** (0.039)	1.008 (0.037)	0.991 (0.037)
Rural areas	1.323*** (0.050)	1.171*** (0.048)	1.037 (0.045)	1.019 (0.045)
C Concessions experience (N = 50,746)				
Towns and suburbs	1.097*** (0.034)	1.053 (0.035)	1.006 (0.034)	0.993 (0.035)
Rural areas	1.243*** (0.044)	1.142*** (0.044)	1.067 (0.043)	1.061 (0.044)
Base model variables	yes	yes	yes	yes
Establishment variables	no	yes	yes	yes
Job variables	no	no	yes	yes
Search variables	no	no	no	yes

Notes: The table displays regression results for three indicators of adaptation behaviour.***, ** and * indicate significance at the 1, 5 and 10 percent level. Region types according to the degree of urbanisation (DEGURBA) from DG REGIO and Eurostat. The reference category is urban areas. All panels report odds ratios from logit models. A list of control variables considered can be found in Table A2 in the Online Appendix.

Source: Own calculations based on IAB-JVS and EHP.

The results in columns (2) to (4) in Table 2 suggest that spatial disparities in adaptation behaviour are due to the specialisation of location types on different kinds of jobs. Estimates summarized in Panel A show that the above average probability of wage concessions in cities seems to be caused first of all by the prevalent type of jobs. For instance, we observe wage concessions more frequently for high-skilled positions that require leadership skills (see Table A7 in the Online Appendix), i.e. jobs that are overrepresented in large cities.¹⁰ Likewise, a higher frequency of concessions with respect to required qualifica-

¹⁰ Niebuhr et al. (2024) and Koster and Ozgen (2021) provide evidence of a greater availability of sophisticated high-quality jobs

tions outside larger cities is also related to the types of jobs on which location types specialize. However, characteristics of the establishments also play a role (see Panel B and C in Table 2). This is confirmed by detailed results of the full model in Table A7 in the Online Appendix. The incidence of concessions regarding qualification declines as establishment size increases, and it tends to be lower in service sectors which are overrepresented in cities. The latter also applies to large firms.

5 Conclusions

This paper investigates spatial disparities in labour shortages using representative micro data on vacancies and establishments in Germany. The analysis provides new evidence on differences in hiring problems, on the factors behind these differences, and on heterogeneous responses of establishments to local labour shortages. Our results point to statistically significant disparities in labour shortages between location types along the urban-rural hierarchy. However, the magnitude of the difference is moderate for most indicators and the spatial pattern differs depending on the applied indicator. This suggests that it is the specificity of hiring problems that varies across location types rather than the overall intensity. These heterogeneous patterns might explain contradictory findings of previous studies that rely on single indicators, which might reflect only particular dimensions of hiring problems.

Findings on the role of composition effects indicate that labour shortages manifest themselves in different ways, in part because local labour markets feature different types of establishment that provide different jobs and use different search channels. However, while the local context does not seem to be the only or even the most important factor behind disparities in hiring problems, spatial factors might add to the differences that result from composition effects. A relatively low number of suitable applications received by rural establishments, for instance, is only to some extent related to composition, leaving room for other factors such as adverse effects of a decline in the local labour supply relative to local demand (cf. Causa et al., 2025).

We also find important differences in firms' adaptation behaviour in response to labour shortages. While establishments in cities are more willing to compromise on wages, concessions on qualification are more frequent outside cities, although rural establishments report problems related to insufficient qualification of applicants less often. In a similar vein, less suitable applicants do not seem to pose more problems to firms in rural areas. These findings suggest that there might also be (spatial) differences in the perception of hiring problems. The assessment of whether or not it was difficult to fill a position is subjective and likely to be influenced by the respondents' previous recruitment experiences and the regional context. Moreover, neither a lower number of applicants nor a longer search duration can be unambiguously interpreted as indicating labour shortages.

In view of the complex spatial pattern of (perceived) hiring problems, composition effects, and firms' adaptation behaviour, the design of effective policies that aim to address hiring problems at the local

in denser locations.

level is challenging. Altogether, our results indicate that location per se is not an extremely important determinant of the extent to which firms perceive hiring problems. This provides little support for a place-based policy that would focus on specific locations which face more severe labour shortages than others. The importance of composition effects rather implies that policy design needs to consider that some establishments (e.g. small firms, specific industries and jobs) face more severe hiring problems irrespective of their location. This is in line with Lee and Cowling (2014) who note that research suggests that place effects may be less important than expected, with the impediments faced by firms determined more by their characteristics than by location.

Policies aiming to reduce hiring problems should nevertheless not be reduced to simple space-neutral measures. There are good arguments in favour of a local policy approach as policies designed to mitigate local labour shortages need to reflect place-specific challenges (OECD, 2024). A monitoring of the local labour market using detailed data on employment and recruiting at a small scale should ideally inform the design of such place-sensitive policies, allowing local agents to consider the characteristics of place-specific labour and skill shortages (Morris et al., 2020). Place-sensitive policies also matter because local amenities tend to affect job attractiveness beyond pay and working conditions. This applies in particular to the recruitment of young high-skilled workers who tend to appreciate urban amenities including leisure and cultural facilities and the provision of public goods such as schools and transportation (Arntz et al., 2023; Jeworrek and Brachert, 2024).

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