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ABSTRACT

Locational Choice and Spatial Wage Inequality*

During the last few decades, aggregate wage growth has been very unevenly distributed across space in Germany. While wages in Southern German local labor markets rose by up to 28 log points, they increased only modestly or even declined in the north. Similar results apply to employment changes. Overall, this has led to a strong positive correlation between local wage and employment growth. What is driving these differential trends across space? This paper examines to what extent regions with growing employment are increasingly paying workers higher wage premia or, in contrast, to what extent the quality of workers in growing regions has risen. To decouple the demand for skill and supply of skill from each other, I estimate how regional wage premia have changed over time using administrative panel data that allow me to hold constant changes in unobserved worker quality. I find that wage premia in regions with expanding employment did not rise more than in regions with declining employment. Instead, the quality of workers in growing regions went up. I investigate the importance of various possible observables for this relationship including local amenity differences, changes in occupation and industry structure as well as variation in education rates. Last, I explore the impact of changing wage premia and changing worker quality on the recent rise in the density wage premium.

JEL Classification: R11, R12, J21, J24, J31

Keywords: location choice, density premium, Roy model

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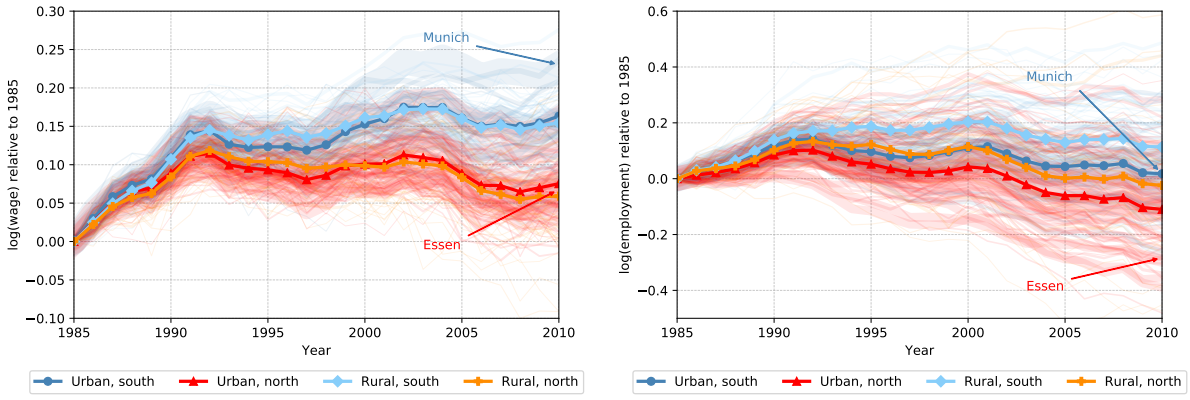
1 Introduction

Inequality in developed countries has increased substantially over the last decades (Acemoglu and Autor, 2011). One important factor contributing to this trend are increasing spatial disparities between booming and declining areas like San Francisco and Detroit in the US or Munich and Essen in Germany (Blanchard and Katz, 1992; Moretti, 2012; Dauth et al., 2019). In fact, these growing disparities have led many countries to implement "place based policies" aimed at reducing regional wage inequality (Glaeser and Gottlieb, 2008; Kline and Moretti, 2014). The reasons for why wages and employment in some areas are rising while shrinking in others are not yet fully understood, however.

Figure 1: Changes in employment and wages across West German regions

(a) Wage changes over time

(b) Employment changes over time



Notes: Figure 1a shows the change in average log wages within local labor markets over time. Figure 1b shows the change in log employment. Shaded lines in the background represent 182 West German detailed local labor markets. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). The thickness of a shaded background line corresponds to the number of employed workers in a local labor market averaged across years 1985 until 2010.

Germany is no exception with respect to large heterogeneity in wage and employment growth across space. While real wages of prime age men in Germany rose by around 10 log points between 1985 and 2010 on average, this wage growth was very unevenly distributed geographically.[1] Figure 1a shows average log wages of 182 distinct German local labor markets relative to 1985. Wages in Southern German local labor markets increased by up to 28 log points but much less so in northern regions – irrespective of being rural or urban. On average,

[1]One may view it also as a consequence of these diverging trends that the German government has appointed a commission on "equitable living conditions" in 2018. The aim of this commission is to provide recommendations for achieving spatial convergence in factors ranging from local debt and employment opportunities to infrastructure, public services and social cohesion. The federal state of Bavaria has even made it the state's obligation to ensure equitable living standards across rural and urban places by incorporating that obligation into its constitution.

southern wages grew by roughly 16 log points and by only 7 log points in the north. The same pattern is to be found in Figure 1b with respect to changes in regional employment. Employment increased in Southern Germany and decreased in the north.

There exist many potential explanations for this but the simultaneous rise in southern wages and employment suggests that demand for workers' skills increased relatively more in the south than in the north. Another potential explanation would be that worker quality rose in Southern Germany; or more generally, that worker quality rose within regions where employment increased. This paper attempts to separate these two competing explanations with the aim to get a more comprehensive answer to the question: are increasing geographical differences driven by spatial changes in the demand for skill or the supply of skill?

For that, I estimate how regional wage premia paid for a unit of skill have changed over time in detailed local labor markets by exploiting administrative panel data with high quality information on workers' location choices. Importantly, the employed estimation method allows workers with heterogeneous skills to self select into local labor markets depending on where they can make the highest wages and profit from other, non-wage aspects which might influence their utility in a generalized Roy model framework (Roy, 1951; Dahl, 2002). This accounts for the fact that differential changes in wages across local labor markets can either be the result of changes in *wage premia* paid to all workers within a local labor market, or be the result of changes in the *quality* of local workers.

I adopt a method which originally focused on estimating returns to occupational skills in the face of worker self selection (Böhm et al., 2019). Therefore, I exploit accelerations and decelerations of individual workers' wage growth over time and by region together with workers' location decisions to estimate changes in local wage premia.[2] Intuitively, the estimated wage premium within a region is rising if workers' individual wage growth accelerated over time and is declining vice versa. The estimating equation is derived from an explicit model of locational choice based on workers' comparative advantage which allows for a structural interpretation of the estimates. This is in contrast to more common fixed effect models (Abowd et al., 1999; Combes et al., 2008, 2012; Dauth et al., 2019). Importantly, identification in the employed method does not rely on the exogenous mobility assumption (made explicit in Combes et al., 2008) and so is largely robust to workers switching location because of idiosyncratic error realizations. Apart from that, one can easily control for differences in life cycle skill accumulation

[2]See Wheaton (1979) and Blanchard and Katz (1992) for early papers which attempt to identify the role of regional supply and demand shocks from local employment growth and wages.

profiles across regions (see also the discussion about the importance of this in Glaeser, 1999; Wheeler, 2006; De la Roca and Puga, 2017).

By exploiting the conditional wage growth of regional movers, I am also able to control and estimate how other, non-wage aspects like local amenities have differentially changed over time. The idea for this is that (conditional) average wage growth associated with switching from a southern region to a northern region should be relatively high if amenities in the north are low. Wage growth then serves as a compensating differential (Rosen, 1986; Roback, 1988; Sorkin, 2018).

I find that local labor markets with growing employment did not feature rising wage premia. This conflicts with the fact that wages in growing regions increased more than in regions where employment declined. It suggests that the simultaneous rise in southern wages and employment is rather due to sorting of high skilled workers into the south than due to increasing southern demand. In fact, the residual between growth in average wages and changes in (quality adjusted) wage premia is informative about changes in worker quality within the model framework. I find that the quality of workers rose more in regions with growing employment, i.e. Southern Germany. Put differently, this suggests that regions with expanding employment exhibit positive skill selection.[3]

There exist several potential explanations for the positive correlation between worker quality changes and employment growth which are independent of the model. First, shifts in observables such as the occupation, education and industry structure might have been different between rising and deteriorating regions (Findeisen and Südekum, 2008). Second, increases in employment density might have raised agglomeration economies making workers and firms become more productive in booming regions (Duranton and Puga, 2004). Third, skilled workers could increasingly sort into high amenity places (Diamond, 2016). I cannot completely separate these (non-exhaustive) explanations. Instead, I will focus on the importance of changes in the occupation, education and industry structure as well as local amenities in greater depth.

I find that regions, in which worker quality improved, also experienced disproportionate increases in the amount of workers employed in managerial, professional and technical (high wage, high skill) occupations. Further, growth in high-skill service and machine building industries as well as growth in the number of university graduates was larger in these regions. In contrast, worker quality declined in markets with rising production and manufacturing em-

[3]This is in strong contrast to the findings in Böhm et al. (2019) regarding occupational growth. Böhm et al. (2019) find that occupational wage and employment growth are uncorrelated because of selection effects in Germany. This is similar to findings for the US by Hsieh et al. (forthcoming).

ployment.

To quantify the magnitude of changes in the industry, education and occupation structure for the correlation between worker quality and employment changes, I perform a reweighting exercise following DiNardo et al. (1996). I reweight observations in 1985 by assigning higher weights to occupation-region (as well as industry-occupation-region and education-region) cells if the number of workers within such a cell increased over time. Using these weights, I recalculate the elasticities between worker quality changes and employment changes. I find that the elasticities drop substantially when reweighting with occupation and industry but much less so for education. This underscores the importance of spatially uneven occupational and industrial change for geographic differences in wage growth (Duranton, 2007; Südekum, 2008; Findeisen and Südekum, 2008; Amior and Manning, 2018).

Furthermore, I find that regions with high estimated amenity values have experienced positive worker quality growth. This is consistent with skilled workers increasingly sorting into areas with high living standards (Diamond, 2016). As the amenity estimates are somewhat noisy because they are identified from movers' wage growth, I additionally collected data on an amenity index reflecting amenities such as sunshine duration, restaurant and physician density as well as data on crime rates and the number of students per school. The amenity index alone is highly predictive of worker quality changes. In line with that, worker quality also increased in areas with low crime rates as a proxy for disamenities. When taking all model independent explanatory variables together (i.e. occupation, industry, education and amenity proxies), 59% of the spatial variation in quality changes can be explained by these observables which is sizable.

In the last step, I use the estimates of changes in wage premia and worker quality to shed light on the rise in spatial wage inequality: I investigate the importance of changing worker quality and changing wage premia for the rising density wage premium; a measure which reflects inequality between rural and urban places and so is important for overall spatial inequality.

I find that dense areas experienced a larger increase in worker quality consistent with the rising density premium. However, improving worker quality was completely offset by declining wage premia in heavily populated areas. Instead, the reason for the rise in the density premium is due to a decline in employment of the formerly densest places (industrial places like the Ruhr area) and a contemporaneous increase in the density of formerly less populated places (mainly in rural Bavaria). Together with changes in average wages being unrelated to

1985's market densities, this has boosted the density wage premium overall.

The remainder of this chapter is as follows. Section 2 discusses the related literature. Section 3 shows facts of regional wage dispersion in Germany, and presents first evidence on workers' spatial self selection patterns. In Section 4, I lay out the employed method and give some evidence on the appropriateness of the required identifying assumptions. I describe the results on how wage premia and worker quality have changed across German local labor markets in Section 5. I also evaluate possible determinants of spatial differences in worker quality changes in that section. Section 6 analyzes reasons for the rising density wage premium. Section 7 concludes.

2 Connection to the Existing Literature

This paper is related to several strands in the urban economics literature. First and foremost, it is related to the literature about spatial sorting of skill across places and the urban wage premium (Berry and Glaeser, 2005; Moretti, 2013; Eeckhout et al., 2014; Dauth et al., 2019).

The closest paper in that part of the literature is work by Combes et al. (2008) who investigate the importance of worker sorting on spatial wage disparities. Using French panel data from administrative records, they find that the elasticity of wages with respect to density drops substantially when including worker fixed effects. They interpret this finding as evidence of sorting of more skilled workers into denser areas.[4]

Three major points distinguish their work from this paper. First, Combes et al. (2008) do not exploit the dynamics of sorting over time. Instead, they are interested in absolute wage differences between more or less dense places. Second, their approach requires much stricter assumptions on the determinants of location decisions. Importantly, they assume that moving decisions must not be based on realizations of idiosyncratic error draws. Although, the approach taken in this paper strictly needs this assumption as well, Böhm et al. (2019) show in Monte Carlo analyses that their method is much more robust to the violation of exogenous mobility. Third, Combes et al. (2008) remain largely agnostic about the mechanism for the sorting effect as they do not derive their estimation strategy from an explicit model describing workers' decisions. Despite that, they acknowledge that self selection of workers based on their comparative advantage may be a reason for higher wages in denser places.

[4] In follow up work, Combes et al. (2012) then estimate full distributions of skill in local labor markets and find that dense places are not only more skilled on average but are also characterized by a higher dispersion of skill consistent with Eeckhout et al. (2014).

The second part of the literature this paper contributes to, deals with the importance of dynamic skill accumulation effects for differences in wages between urban and rural workers (Glaeser, 1999; D'Costa and Overman, 2014). For example, in contrast to Combes et al. (2008), De la Roca and Puga (2017) find that workers in cities do not have higher unobserved ability than other workers initially, but instead accumulate skills at a faster rate through learning by working in dense places. Workers take the accumulated skills with them when leaving to less dense places. De la Roca and Puga (2017) argue that the sorting effect found by Combes et al. (2008) is rather due to the higher skill accumulation present in cities which leads to biased fixed effects estimates. Complementary to their work, this paper also accounts for the importance of spatial differences in skill accumulation. I find that, indeed, denser places exhibit much steeper skill accumulation profiles.

Third, this paper adds to the literature on the importance of local amenities for location decisions, urban growth and inequality (Rosen, 1986; Roback, 1988; Glaeser et al., 2001). For instance, Diamond (2016) investigates the changing sorting pattern of college and non-college workers in the US based on wages, housing prices as well as local amenities. She finds that college workers increasingly concentrate because of differential changes in local demand. This sorting comes at the cost of higher increases in local rents in skilled areas, however. In turn, these high rent places also have high amenities to compensate and attract high skilled workers. In the estimation, I account for the fact that workers' location decisions not only depend on potential wages but also depend on local prices and amenities. In a final step, I exploit correlations between the estimated amenity values (as well as externally collected amenity data) and worker quality estimates.

The last part of the related literature deals with the role of spatial changes in the occupation and industry structure for local employment and wage growth (Blanchard and Katz, 1992; Duranton, 2007; Dustmann and Glitz, 2015; Amior and Manning, 2018). With respect to the German case, for instance, Findeisen and Südekum (2008) evaluate the importance of changes in the local industry structure as well as human capital for urban growth. In line with them, I also find that regions, which were able to "reinvent" themselves by adopting to a changing occupation-industry structure, exhibited rises in worker quality. This highlights the importance of structural change taking place unevenly across space (Autor, 2019).

3 Spatial Changes in Wages and Employment

3.1 Data

For all of the analyses, I make use of the Sample of Integrated Labor Market Biographies (SIAB) Regional File provided by the IAB Institute at the German Federal Employment Agency. The SIAB is a 2% random sample of administrative social security records from 1975 to 2014. It is representative of 80% of the German workforce and includes employees covered by social security, marginal part-time employment, benefit receipts, officially registered as job-seeking or participating in programs of active labor market policy. The SIAB excludes the self-employed, civil servants, and individuals performing military service. Most notably, it contains individuals' full employment histories including detailed data on wages, place of work, occupation and industry along with socio-demographics such as age, gender, and the level of education.

Place of work corresponds to the political district (Landkreis) a plant is located in.[5] I map every district (in former West Germany) into one of 182 local labor markets and drop all observations within East German districts. The classification of local labor markets is based on commuting flows of workers as described in Kropp and Schwengler (2011) and Dauth et al. (2019).[6] I further aggregate these 182 local labor markets into four categories: urban - south, urban - north, rural - south, and rural - north. The assignment of regions to rural and urban markets is based on a classification of BBSR (2014). Southern regions are located in the federal states of Baden-Wuerttemberg and Bavaria. Appendix A.1 provides more information on the spatial distribution of this classification.

I prepare the data in the exact same way as Böhm et al. (2019). Importantly, I transfer the spell structure into a yearly panel by deleting all spells except for the longest spell within a year. I stochastically impute wages above the social security limit (as in Card et al., 2013), and restrict the sample to 25 to 54 year old German men working full-time in former West Germany between 1975 and 2010.

For some parts of the analysis, I rely on aggregations of detailed occupations, industries and education. See Appendix A for the details. Appendix A also contains information on collected amenity data and local price indices.

[5] Theoretically, a move between districts can therefore also reflect the move of a plant. This is very rare in practice, however.

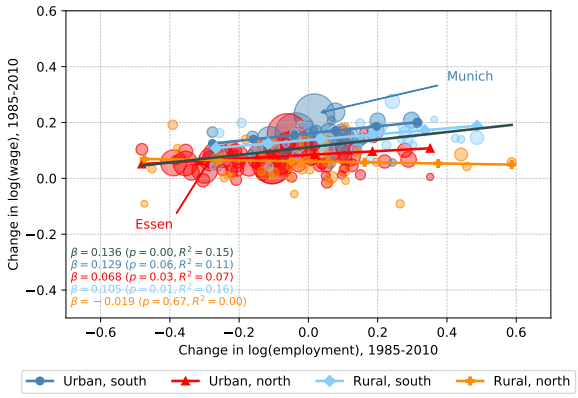
[6] The number of 182 local labor markets differs from the 204 markets which Dauth et al. (2019) use in their main analysis because some rather sparsely populated districts are aggregated further due to data anonymization in the Scientific Use File I exploit. Hence, where the mapping is not one to one, I further aggregate these local labor markets into larger markets. See Ganzer et al. (2017, Table A.9) for the exact aggregation of districts because of anonymization in the SIAB Scientific Use File.

3.2 The Geography of Wage and Employment Changes Across Germany

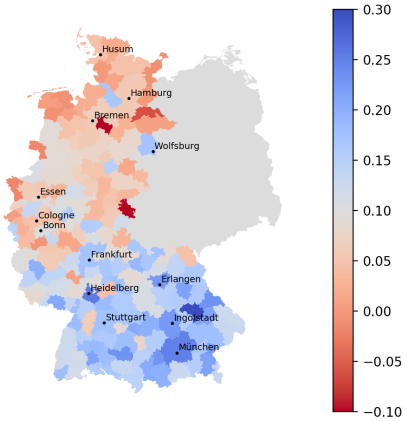
German wage inequality has increased a lot during the last few decades (e.g. Dustmann et al., 2009). An important contributing factor are rising wage differentials across space (Moretti, 2013; Dauth et al., 2019). What are the drivers of these increasing spatial differences? Are they the result of demand having declined in previous industrial clusters like the Ruhr area; but having increased in Southern Germany where many high tech firms operate (Findeisen and Südekum, 2008)? Or are these spatial changes the result of high skilled workers increasingly moving to high amenity areas (Diamond, 2016)?

Figure 2: Relation between employment growth and wage growth

(a) Employment changes and wage changes



(b) Average wage changes, 1985 – 2010



Notes: The vertical axis in Figure 2a shows the change in average log wages between 1985 and 2010. The horizontal axis depicts the change in log employment between 1985 and 2010. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers. Figure 2b plots the change in average log wages between 1985 and 2010 across Germany. East Germany is left out of the analysis.

Figure 2a shows that regional wage and employment changes have been strongly correlated in West Germany. Rising employment was accompanied by rising wages: a region with 10% more employment growth experienced 1.4% more wage growth on average. Geographically, wages primarily grew in Southern Germany (see Figure 2b) and stayed largely constant or even declined in the north.

There are two distinct explanations for the positive correlation between wage and employment growth. First, this positive correlation seemingly suggests that regions with rising employment experienced increases in demand for skill leading to employment and wage gains. This assessment, however, crucially relies on the composition of worker quality not having

changed over time in response to the change in demand. This brings me to the second possible explanation: if the quality of the average worker in a growing region increased much more than the quality of the average worker in a region with declining employment, changing supply of skill would be the more important factor for growing wage disparities.

To separate these explanations, the next section presents a method for estimating how wage premia, paid for a unit of skill, have changed over time and across space. Crucially, the method will account for the possibility that workers might self select into regions thereby altering the skill composition (Combes et al., 2008, p. 15, footnote 27); and that life cycle skill accumulation might be different across regions, for instance, because urban places facilitate learning (Glaeser, 1999; De la Roca and Puga, 2017).

But before that, I will briefly summarize evidence that the positive correlation between wage and employment growth is rather due to a changing skill composition than due to spatial differences in altering wage premia. Appendix B presents four stylizes facts. It shows correlations between local employment growth and (1) changes in occupational employment shares, (2) changes in industrial employment shares, (3) changes in education shares as well as (4) relative wages of regional entrants.[7] These correlations are informative about the observable types of attracted workers (e.g., high or low skilled) and the types of jobs workers in growing regions increasingly perform (e.g., service or high-tech). In total, these stylized facts suggest that growing regions were able to attract workers of comparably high quality as well as jobs performed in occupations and industries located in the upper part of the wage distribution.

In fact, the share of workers in managerial, professional and technical (high wage, high skill) occupations increased much more in growing than in declining regions (see Appendix B.1). The opposite is true for service and care (low wage, low skill) occupations whose share decreased in regions with growing employment. The geography of changes in the share of managerial, professional, and technical occupation is striking. Despite the number of workers in that group increased by roughly six percentage points between 1985 and 2010 overall, this rise almost exclusively took place in Southern Germany.

A similar result applies to changes in industrial employment shares (see Appendix B.2). I aggregate industries following Bárány and Siegel (2018) into manufacturing, high-skill services and low-skill services. In addition, I distinguish the machine building sector from the remaining manufacturing sectors because of Germany's large and increasing number of firms engaged in machine engineering (Findeisen and Südekum, 2008). In fact, wages within ma-

[7] Appendix B also shows maps which plot the variation of these variables across space.

chine building are the highest across industries and have even increased much more over time than in high-skill services (21 log points compared to 8 log points). On average, the share of workers employed in machine engineering firms increased in growing local labor markets and declined vice versa. In contrast, both high- and low-skill services primarily grew in regions with declining employment. Therefore, not only the share of workers employed in high paying *occupations* rose within expanding regions over time; but also the share of workers employed in high paying *machine building* firms. Similar to the shares of high wage, managerial, professional and technical occupations, most of the local labor markets with increasing machine building shares were located in rather rural Southern Germany. This region underwent a dramatic transformation process. It was formerly "dominated by traditional industries but then developed rapidly over the 1970s and 1980s to become one of Germany's leading high-tech states" (Findeisen and Südekum, 2008, p. 15).

Contrary to that, there is no relation between employment growth and changes in the share of university graduates (see Appendix B.3). Indeed, neither the share of university graduates nor the shares of medium or low educated workers increased differentially between growing and declining regions. The main reason is that growth in the proportion of university graduates primarily took place within cities which did not become denser over time. I will come back to this interesting observation in Section 6.

Last, Appendix B.4 shows average wages of entrants to local labor markets relative to the wages of incumbents. This exercise is informative about the pattern of market entrants' quality across space. An entrant can be anybody who is newly observed in the local labor market in the current period, joining the labor force for the first time, switching from a different region, or entering from unemployment or outside of the labor force. Clearly, under that definition, all relative entry wages are well below zero. This is not surprising because entrants typically have less experience than incumbents and their matching might be worse. What is more surprising, however, is the positive relationship between entry wages and employment growth: the more employment within a local labor market is growing, the higher are relative entry wages. This finding is consistent with the hypothesis that entrants to regions with rising employment are of comparably high quality which is reflected in their comparably high wages. [8] Appendix B.4 further shows that the positive relationship still holds when controlling for age, education or occupation.

[8] Böhm et al. (2019) find the exact opposite with respect to occupational employment growth: the more an occupation is growing, the lower are the wages of entrants to that occupation relative to the wages of incumbents.

Nevertheless, the positive correlation does not appear when defining an entrant as a mover joining the region from another local labor market only. Under that definition, the positive correlation falls close to, or even below zero.[9] In fact, the correlation between employment growth and relative entry wages is mainly driven by labor market entrants. One reason for that might be that schooling systems of growing regions in Southern Germany are comparably better (Combes et al., 2012).[10] Another explanation could be that most of the sorting of workers happens right after their graduation from school or university.

In summary, with the exception of changes in education shares, regions with growing employment seem to have experienced comparably positive changes in their occupation and industry structure as well as seem to have attracted entrants of relatively high quality. This already suggests that worker quality might have improved in regions with growing employment. The next sections will investigate this in detail.

4 Estimating Local Wage Premia and Amenities

This section shows how to estimate changes in location specific wage premia paid for a unit of skill as well as changes in local amenities within a generalized Roy model setting (Roy, 1951; Dahl, 2002). The method applies an insight from Böhm et al. (2019) on the relation between wage growth of individual workers and their location choices in panel data allowing for worker self selection because of changing wage premia and changing amenities at the same time. The method leads to an estimation strategy which is feasible also for a large set of local labor markets.

4.1 Model

Worker i at time t faces the problem of choosing in what potential local labor market $l = 1, \ldots, L$ to work in. The worker is assumed to choose the region in which his (log) utility would be highest:

$$u_{i,t} = \max\{u_{1,i,t}, \ldots, u_{L,i,t}\} = \sum_{l=1}^{L} I_{l,i,t} u_{l,i,t} \tag{1}$$

The realized utility of a worker depends on the chosen location $I_{l,i,t} \equiv \mathbb{1}[u_{l,i,t} \geq u_{j,i,t} \, \forall j \neq l]$. This choice, in turn, hinges on latent (real) wages $w_{l,i,t}$ the worker can potentially earn in the

[9] Notice that this might also provide evidence against the hypothesis that growing regions need to pay higher wages to attract workers because of search frictions. If that were true, relative entry wages of movers should also be positively correlated with local employment growth.

[10] Consistently, the ratio of students per school is lower in growing regions. I will come back to this later.

different regions as well as non monetary local amenities $v_{l,i,t}$ in a linear and additive way.[11] This rationalizes that not all workers move to the best paying regions immediately but weigh up wages and amenities (Rosen, 1986; Roback, 1988):

$$u_{l,i,t} = w_{l,i,t} + v_{l,i,t} \tag{2}$$

Potential wages $w_{l,i,t}$ depend on the worker's individual skill $s_{i,t}$ common across regions and their contemporaneous return in the local market $\pi_{l,t}$. Hence, for a given unit of skill, the worker might obtain a very different wage premium depending on where he chooses to work. Variation in wage premia might exist in spatial equilibrium because, for instance, demand in some places might be higher than in other places (Bound and Holzer, 2000). In addition, potential real wages depend on a time constant price index r_l which describes differences in price levels across areas.[12] The choice model therefore reflects workers balancing wages, amenities and local prices in equilibrium as is common in the urban economics literature (Glaeser, 2008).

Furthermore, latent amenities hinge on the (overall) local amenity value of a region $\psi_{l,t}$ as well as an idiosyncratic evaluation of a region $\varepsilon^v_{l,i,t}$. This specification rationalizes, for instance, workers switching out of regions with highest wage premia and highest amenities and into low return, low amenity regions for idiosyncratic reasons:

$$w_{l,i,t} = \pi_{l,t} + s_{i,t} - r_l \tag{3}$$

$$v_{l,i,t} = \psi_{l,t} + \varepsilon^v_{l,i,t} \tag{4}$$

The main aim of this paper is to estimate how local wage premia $\pi_{l,t}$ have evolved over time across different local labor markets as well as how amenities $\psi_{l,t}$ have changed across regions. Böhm et al. (2019) show how one can estimate these parameters in panel data with information on workers' individual wage growth as well their decision in what market to work in.[13] Building upon their insight and letting Δ denote changes between periods $t-1$ and t, workers'

[11] Note that log additivity implies that latent utilities in non-log terms are defined as: $U_{l,i,t} = W_{l,i,t}V_{l,i,t}$. This implies that wages and amenities are complements for a worker so that an amenity is valued the more, the higher the wage is. This might reflect that workers can only enjoy amenities if their wage is sufficiently high.

[12] Data on local price differences comes from Kawka et al. (2009) who compute consumer prices by district with prices collected between 2006 and 2008. Unfortunately, up to now, there is no comprehensive panel data available with information on how prices have changed over time and across German regions.

[13] In their application, a market refers to an occupation k. See their Appendix B for the details on the derivation of an estimable equation with respect to both changing occupational skill prices and amenities.

real wage growth can (approximately) be described by a linear equation:

$$\Delta w_{i,t} = \sum_{l=1}^{L} \bar{I}_{l,i,t} \Delta w_{l,i,t} - \sum_{l=1}^{L} \Delta I_{l,i,t} \bar{v}_{l,i,t} \tag{5}$$

$\bar{I}_{l,i,t} = \frac{I_{l,i,t-1}+I_{l,i,t}}{2}$ is an "average" choice indicator equal to 0 when worker i did neither work in l at t or $t-1$; equal to 1 if he decided to stay in l between these periods; and equal to 0.5 if he either entered or left l at t or $t-1$. Hence, $\bar{I}_{l,i,t}$ describes the average sorting between two periods.[14]

In turn, $\Delta I_{l,i,t} = I_{l,i,t} - I_{l,i,t-1}$ contains information on the changing sorting. $\Delta I_{l,i,t}$ equals +1 if i switched into l at t, equals -1 if i left l at t, and is zero otherwise. Because of the general difference between $\Delta I_{l,i,t}$ and $\bar{I}_{l,i,t}$ when there is enough regional mobility, average amenities and changes in potential wages can be separately identified from workers' wage growth and their location decisions relative to a base period $t = T_{base}$ and relative to a base region $l = L_{base}$.

Intuition In total, Equation (5) consists of two sums. The first summand on the right hand side of Equation (5) is a purely pecuniary part: if a worker stays in local labor market l ($\bar{I}_{l,i,t} = 1$, $\Delta I_{l,i,t} = 0$), his observed wage gain equals the potential wage change $\Delta w_{l,i,t}$ in that local labor market. In turn, the potential wage change depends on how market wage premia evolve and how the worker's skill changes.

In contrast, if the worker switches from market l to m ($\bar{I}_{l,i,t} = \frac{1}{2}$, $\Delta I_{l,i,t} = -1$ as well as $\bar{I}_{m,i,t} = \frac{1}{2}$, $\Delta I_{m,i,t} = 1$), one half of his wage growth is approximated to stem from the origin region's potential wage change; and one half of the wage growth to stem from the destination region's potential wage change. The exact allocation of wage growth into origin and destination region is unknown as the data does not contain any information at what exact wage the worker would be indifferent (Böhm et al., 2019).

However, the observed wage change of a moving worker will not only depend on pecuniary motives. Instead, the observed wage change also depends on the amenity differences between regions l and m as amenities serve as compensating differentials in this framework (Rosen, 1986; Roback, 1988). If, for instance, amenity values in Northern Germany are comparably low, wage growth of switchers from Southern to Northern Germany should be relatively high to compensate workers for the potential decline in utility due to low amenities in the des-

[14] Likewise, $\bar{v}_{l,i,t} = \frac{v_{l,i,t}+v_{l,i,t-1}}{2}$ denotes the average amenity value of region l between $t-1$ and t including the systematic part $\bar{\psi}_{l,t} = \frac{\psi_{l,t}+\psi_{l,t-1}}{2}$ as well as the idiosyncratic part $\bar{\varepsilon}^{v}_{l,i,t} = \frac{\varepsilon^{v}_{l,i,t}+\varepsilon^{v}_{l,i,t-1}}{2}$.

tination region. Not accounting for the importance of amenities in location decisions (as is also the case in simple fixed effects models) might therefore severely bias the results as high wage growth of movers would then be attributed to high skill growth.[15]

The second summand on the right of Equation (5) incorporates the influence of amenities on workers' observed wage growth: with optimal choices, a worker's observed wage growth is the change in the potential wage of the destination region minus the utility gain (or loss) from the behavioral response of switching region. That is, if a utility-optimizing worker chooses to move from the less desirable region l to the more desirable region m, in the data that worker's wage growth should be *lower* than predicted by the changing relevant potential wage alone. Vice versa, observed wage growth should be *higher* than the potential wage change when a worker moves from a more desirable region to a less desirable one.

Average amenity values can therefore be identified by comparing the (conditional) wage growth of movers to the wage growth of stayers. However, I can only identify them relative to a base region which I choose to be the rural region $L_{base} =$ Husum located in the most northern part of Germany. Mechanically, the reason is that the $\Delta I_{l,i,t}$ sum to zero over all l which leads to multicollinearity. The economic reason is that choices and wages can only be used to identify relative utilities but not utility levels.

Disentangling growth in wage premia from growth in individual worker quality requires a further parameterization of the skill accumulation function:

$$\Delta s_{i,t} = f(X_{i,t-1}) + \varepsilon^s_{i,t} \tag{6}$$

$$= X_{i,t-1}\Gamma_{l',l} + \varepsilon^s_{i,t} \tag{7}$$

According to Equation (7), workers' skill accumulation linearly depends on observables $X_{i,t-1}$ and an unobservable skill shock $\varepsilon^s_{i,t}$ which influences workers' productivity commonly across all regions. I allow skills to change over the life cycle with the speed of skill growth varying by age group (in the empirics, I use dummies for ages 25 – 34, 35 – 44 and 45 – 54). Further, I allow age profiles to vary with previous (l') and current (l) work location. This reflects the fact that skill accumulation might be higher in urban places (Glaeser, 1999; De la Roca and Puga, 2017). As described later, using such a fully saturated skill model also helps in dealing with endogeneity of the choice with respect to error realizations. Inserting this yields the following

[15]Notice that in a fixed effect model, the estimated fixed effect of a worker moving from a high amenity to a low amenity region would be higher compared to a scenario in which amenities play no role. The reason for this is that the worker would be compensated for this less favorable move by a rising wage (Sorkin, 2018). In fact, part of mover's fixed effect would reflect amenity differences between regions instead of worker's time constant ability.

estimation equation with parameters $\Delta\pi_{l,t}, \bar{\psi}_{l,t}, \Gamma_{l',l}$ estimable by ordinary least squares:[16]

$$\Delta w_{i,t} = \sum_{l=1}^{L} \bar{I}_{l,i,t}(\Delta\pi_{l,t} + \Delta s_{i,t}) - \sum_{l=1}^{L} \Delta I_{l,i,t}\bar{v}_{l,i,t} \tag{8}$$

$$= \sum_{l=1}^{L} \bar{I}_{l,i,t}(\Delta\pi_{l,t} + X'_{i,t-1}\Gamma_{l',l}) - \sum_{l=1}^{L} \Delta I_{l,i,t}\bar{\psi}_{l,t} + \eta_{i,t} \tag{9}$$

4.2 Identifying Assumptions

I now make the assumptions explicit which are necessary for a consistent estimation of the main parameters of interest $\Delta\pi_{l,t}, \bar{\psi}_{l,t}$ and provide evidence for their plausibility.

Constant Skill Accumulation Function As already noted in Equations (6) and (7), the function describing the accumulation of workers' skills $\Delta s_{i,t} = f(X_{i,t-1}) + \varepsilon^s_{i,t} = X_{i,t-1}\Gamma_{l',l} + \varepsilon^s_{i,t}$ must not contain a time t subscript to avoid perfectly collinearity between changes in wage premia and skill changes since $\bar{I}_{l,i,t}$ is interacted with both $\Delta\pi_{l,t}$ (i.e., year dummies) as well as $X_{i,t-1}\Gamma_{l',l}$ (i.e., dummies for age groups, previous and current location). This, in turn, implies the assumption that skill growth over the life cycle for a worker starting in a market in 1975 is the same as it was in 2010.[17] Note that this assumption does not make any restrictions on the skills of entering workers so that the average skill can change freely. Unfortunately, this identifying assumption is not testable directly.

Nevertheless, Figure 3 shows that wage growth rates between age groups did not change too much during 1985–2010, at least within the four aggregated local labor markets. The figures present a difference-in-difference result showing residual wage growth of young workers (25–34 year olds, Figure 3a) and middle aged workers (35–44 year olds, Figure 3b) relative to older workers (45–54 year olds) over time. Holding everything else constant in the model, wage growth differences between two samples in different age groups but the same local market should only reflect changes in skill accumulation between these two groups over time as wage premia and common amenities cancel out for workers within a region. The missing of a clear trend in these figures shows that wage growth between age groups (and thereby skill growth rates in the model) did not change much over time.

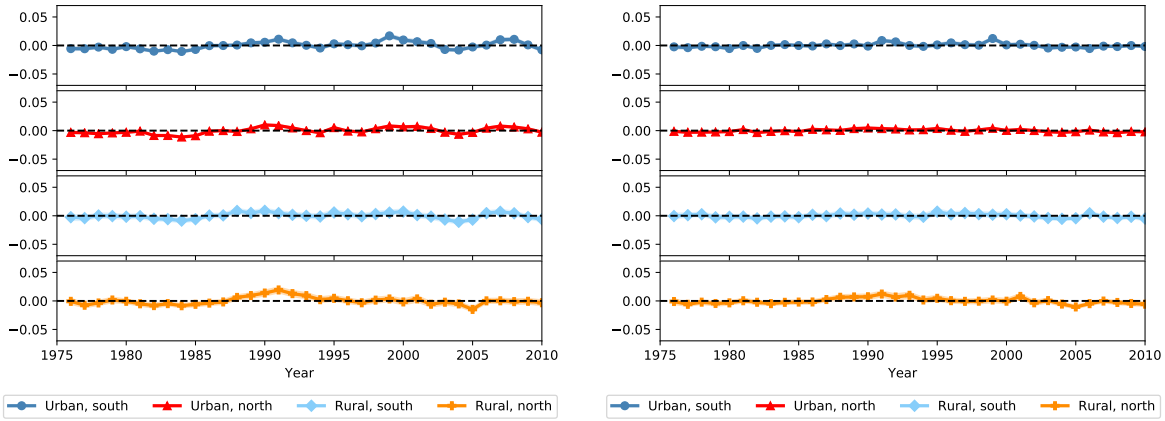
[16] Notice once more that the local price index used to deflate wages across space is time constant because of lacking panel data (Kawka et al., 2009). As the estimation method will exploit changes over time, the price index cancels out in $\Delta w_{i,t}$ for regional stayers, therefore. Wage growth of movers, which is especially relevant for the estimation of amenities, depends on differences in local prices and so does not cancel out, however.

[17] This assumption is the same as in Acemoglu and Autor (2011) and Yamaguchi (2018). Complementary to that, Heckman et al. (1998) propose to use old workers for estimation of skill price changes as their wage growth might be less confounded by skill growth.

Figure 3: Wage growth differences

(a) 25–34 relative to 45–54 year olds

(b) 35–44 relative to 45–54 year olds



Notes: The lines show average individual wage growth from $t-1$ to t by year of 25–34 (Figure 3a) and 35–44 (Figure 3b) year olds minus average wage growth of 45–54 year olds. Results are centered at zero to show trends over time. The shaded areas around the four lines are 95% confidence intervals. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014).

With respect to the detailed local labor markets, Appendix Figure C.1 shows a difference-in-difference-in-difference (i.e., triple difference) result. First, I split the sample in the middle (1993). Then I calculate workers' wage growth between two periods and subtract the wage growth of 45–54 year olds from the wage growth of 25–34 year olds and 34-45 year old workers. After that, I take averages before and after 1993 and subtract them from each other. Figure C.1 shows the results of this exercise plotted against employment changes. Admittedly, there is more variation than for the four broad regions so that the assumption of a time constant skill accumulation function is possibly not exactly fulfilled for every local labor market. However, most of the accelerations or decelerations in wage growth after 1993 are very close to zero. Importantly, there seems to be no relation to employment growth.

Base Period With Constant Wage Premia To separately identify changes in wage premia and skill accumulation parameters from each other, a further restriction on the change in wage premia is necessary: there needs to be a period in which wage premia have been constant. Setting $\Delta\pi_{l,t} = 0, t = 1975, \ldots, T_{base}$ then allows me to estimate $\Gamma_{l',l}$ in that period. As $\Gamma_{l',l}$ does not change over time by assumption, the conditional wage growth after T_{base} is, hence, informative on the change in wage premia. Analog to Böhm et al. (2019), I set the end of the base period to $T_{base} = 1985$ for having enough variation to estimate the skill accumulation parameters. Controlling for how wage growth evolves over the life cycle, the excess wage growth in $t > T_{base}$ therefore informs the estimates about the changing returns.

Again, this identifying assumption is not testable directly. However, Appendix Figure C.2 shows that wage and employment changes were much less pronounced between 1975 and 1984. In addition, the figure shows that there has been no change at all in the density size premium taken place between 1975 and 1985.[18] Overall, these results suggest that the time period 1975–1984 was at least a period with less wage and employment changes compared to 1985–2010. In addition to that, Böhm et al. (2019) show that, even when the assumption of constant premia in the base period were violated, the method still identifies an important parameter: namely, how wage premia changed relative to the change that occurred during 1975–1984. That is, how much the change in wage premia accelerated or decelerated over time.

Distribution of Shocks If $\bar{\varepsilon}^v_{l,i,t}$ is not common across all markets $l = 1, \ldots, L$ and therefore the locational choice is influenced by the the error draw, a correlation between the choice variables and the error appears which leads to an endogeneity bias because:

$$\eta_{i,t} = \varepsilon^s_{i,t} - \sum_{l=1}^{L} \Delta I_{l,i,t} \bar{\varepsilon}^v_{l,i,t} \tag{10}$$

Nevertheless, l specificity of $\bar{\varepsilon}^v_{l,i,t}$ makes the model much more realistic as workers move in all kinds of directions during their life cycle for presumably idiosyncratic reasons.[19] This is why Böhm et al. (2019) show a large set of Monte Carlo experiments which suggest that the bias is of small magnitude in realistic scenarios. The reason for that is that the interaction between previous and current work location in the fully saturated skill accumulation model already picks up most of the endogeneity as the corresponding parameters in $\hat{\Gamma}_{l',l}, l' \neq l$ are identified from the (time constant) sorting of regional movers together with their (biased) wage growth stemming mainly from the error realizations.

In fact, region specificity of $\bar{\varepsilon}^v_{l,i,t}$ introduces a substantial bias in the estimates for the skill accumulation parameters $\hat{\Gamma}_{l',l}, l' \neq l$. However, if the shock distribution stayed constant during the base period and afterwards, the overall bias for the (time varying) wage premium estimates and the (time varying) amenity estimates is minimal: there should be no excess wage growth due to the shocks after the base period compared to the wage growth which took place during the base period (provided the shock distribution remained constant). Notice that this is

[18] I measure this premium as the elasticity of average wages with respect to market density. Market density is defined as the number of employed workers in a local labor market divided by the area of a market in square kilometers. The elasticity was 6.9 log points in 1975 and 7.0 log points in 1985.

[19] I assume that skill shocks $\varepsilon^s_{i,t}$ have the same influence across all local labor markets. This is in line with the assumption that worker productivity is the same across all regions. Hence, there is no endogeneity problem with respect to the skill shocks as they do not influence workers' location choices.

different for fixed effects models as in Combes et al. (2008) who rely on the exogenous mobility assumption which postulates that workers must not move because of idiosyncratic shock realizations.

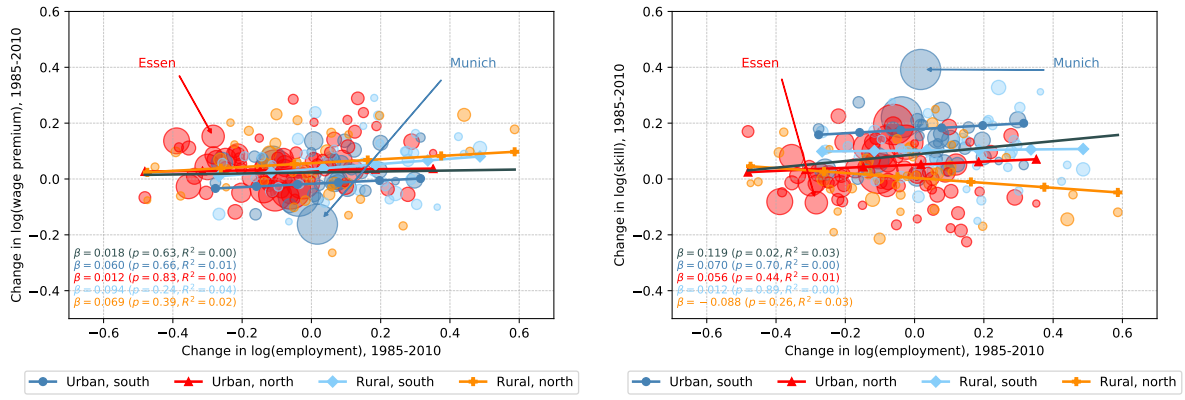
5 Local Wage Premia and Worker Quality

This section first presents the estimates of changes in wage premia paid for a unit of skill and changes in worker quality. After that, I show observable determinants of changing worker quality which includes evidence on spatial differences in the occupation, industry and education structure as well as variation in local amenities.

Figure 4: Worker quality increased in growing regions

(a) Changes in wage premia

(b) Changes in worker quality



Notes: Figure 4a shows estimated changes in local wage premia between 1985 and 2010. OLS estimates as described by Equation (9). Figure 4b shows estimated changes in worker quality as described by Equation (11). The horizontal axes depict the change in log employment between 1985 and 2010. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

Figure 4 shows the main result of this paper. Changes in local wage premia and employment growth between 1985 and 2010 were essentially uncorrelated across local labor markets (p-value = 0.63). Put differently, changes in wage premia paid for a unit of skill were roughly equal between declining and growing regions. This finding is in contrast to Figure 2 which showed that growing employment came in hand with growing wages. Figure 4b shows the reason for this. It plots the change in worker quality between 1985 and 2010 by market as the

residual between changes in wage premia and changes in average wages:

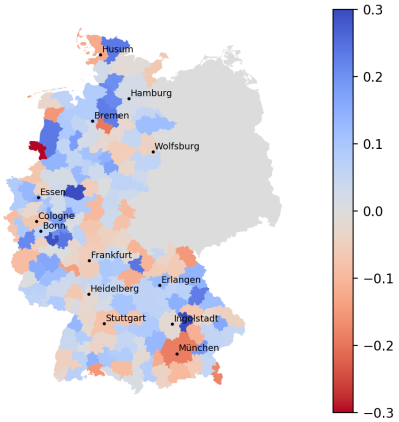
$$\sum_{t=1986}^{2010} \underbrace{\mathrm{E}[s_{l,i,t}|I_{l,i,t}=1] - \mathrm{E}[s_{l,i,t-1}|I_{l,i,t-1}=1]}_{\text{mean skill change in } l} = \sum_{t=1986}^{2010} \underbrace{\mathrm{E}[w_{i,t}|I_{l,i,t}=1] - \mathrm{E}[w_{i,t-1}|I_{l,i,t-1}=1]}_{\text{mean wage change in } l} \tag{11}$$

$$- \sum_{t=1986}^{2010} \underbrace{\Delta\pi_{l,t}}_{\text{change in wage premium}}$$

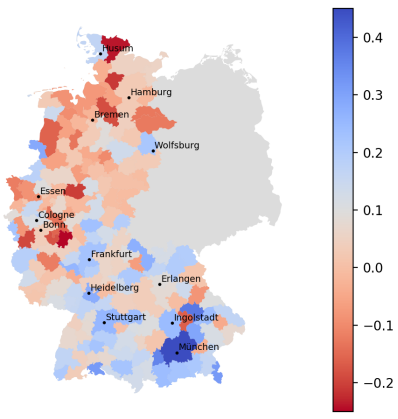
Worker quality strongly increased in regions with growing employment. On average, a market whose employment increased by 10% experienced an increase in worker quality of 1.2%. This finding is in line with the hypothesis that growing regions were able to attract workers of comparably high quality as already suggested in Section 3.2 that showed remarkable differences in changes of the occupation and industry structure between growing and shrinking regions.

Figure 5: Geography of changes in wage premia and skills, 1985 – 2010

(a) Changes in wage premia



(b) Changes in worker quality



Notes: Figure 5a shows estimated changes in local wage premia between 1985 and 2010. OLS estimates as described by Equation (9). Figure 5b shows estimated changes in worker quality as described by Equation (11). Assignment of political districts to West German local labor markets is based on commuting flows and follows Kropp and Schwengler (2011). East Germany is left out of the analysis.

Figure 5 shows the differential changes in wages premia and worker quality across Germany. There appears to be no clear pattern with respect to changes in wage premia (Figure 5a). In contrast, Figure 5b suggests that worker quality primarily increased in Southern Germany.[20]

The general pattern of improving worker quality also appears when using different es-

[20] Appendix Figure D.1 shows the accumulated skill of a hypothetical stayer by market density. In line with De la Roca and Puga (2017), I find that workers in urban places have higher skill accumulation rates. However, there is also a lot of variation between urban places. For instance, stayers' estimated skills at age 54 in Munich are roughly 60 log points higher than in Essen. Part of this difference might be explained by differences in the occupation structure with high shares of low accumulation, production jobs in Essen and high accumulation, professional jobs in Munich. See Böhm et al. (2019) for skill profiles by occupation.

timation methods. Appendix D shows the results of four robustness checks. First, I drop the terms in Equation (9) which control for changing local amenities. This increases the elasticity between skill and employment changes further. Second and third, I allow for a more flexible skill accumulation function by including dummies for occupation and education separately. This also slightly increases the elasticity between worker quality changes and employment changes. Last, I estimate changes in wage premia using a fixed effects approach following Cortes (2016). I identify changes in wage premia from year times region dummies and control for unobserved worker quality with worker times region fixed effects. Additionally, I allow for region specific, concave wage profiles over the life cycle by adding age times region dummies to the regression. Using this complementary approach, the estimated skill elasticity rises further.

In summary, in all of these robustness checks, there is a zero (or even negative) correlation between changing wage premia and employment growth. In contrast, employment growth and skill changes are strongly correlated in all specifications.

There are several (model independent) explanations for the positive correlation between worker quality changes and employment growth as well as the concentration of positive worker quality changes in Southern Germany: shifts in observable characteristics such as the occupation, education and industry structure might have been different between booming and declining regions (Findeisen and Südekum, 2008); increasing density of employment could have raised agglomeration economies in booming regions making workers and firms become more productive (Duranton and Puga, 2004); there might be an important role which local amenities play to attract skilled workers (Glaeser et al., 2001; Diamond, 2016).

My aim in this paper is not to fully disentangle these explanations or even uncover causal relations that determine the performance of local labor markets. Instead, I will develop new stylized facts about the processes of changing worker quality and employment growth: what have been the main (observable) characteristics of successful places that experienced a growth in all three: wages, worker quality and employment? I will focus on the role played by occupations, industries and education as well as local amenities in greater depth.

5.1 The Role of a Shifting Occupation, Industry, and Education Structure

It is well documented across a wide range of countries that the distribution of occupational and industrial employment has shifted a lot of over the last few decades. Employment declined in routine, producing occupations and increased in analytical, professional as well as manual, service jobs (Dustmann et al., 2009). Similarly, employment decreased in manufactur-

ing industries and rose in high- as well as low-skill services (Bárány and Siegel, 2018).

What has been less well documented is the fact that changes in occupational and industrial employment are far from evenly distributed across regions within countries (Autor, 2019). Section 3.2 already showed up huge differences in changes of the occupation and industry structure across space. For instance, although the countrywide share of employment within producing occupations decreased from 58 percentage points to 50 points over time in Germany, the shifts across local labor markets range from -18 to +3 percentage points (see Appendix Figure B.1c). In this section, I will now investigate the impact of differential changes in the occupation, industry, and education structure on changes in worker quality.

Table 1: Observable determinants of changing worker quality

		$\Delta\bar{s}_{l,2010}$	$\Delta\bar{s}_{l,2010}$	$\Delta\bar{s}_{l,2010}$	$\Delta\bar{s}_{l,2010}$	$\Delta\bar{s}_{l,2010}$	$\Delta\bar{s}_{l,2010}$	$\Delta\bar{s}_{l,2010}$	$\Delta\bar{s}_{l,2010}$
Panel A									
Occupation growth	Mgr-Prof-Tech	0.30 (0.00)							0.14 (0.04)
	Sales-Office	0.08 (0.06)							-0.07 (0.26)
	Prod-Op-Crafts	-0.36 (0.00)							-0.52 (0.01)
	Srvc-Care	-0.04 (0.10)							-0.09 (0.00)
Panel B									
Industry growth	Machine building		0.06 (0.01)						0.08 (0.02)
	High-skill services		0.19 (0.00)						0.21 (0.00)
	Manufacturing		-0.15 (0.00)						0.04 (0.31)
	Low-skill services		-0.07 (0.11)						0.07 (0.10)
Panel C									
Education growth	University degree			0.13 (0.00)					-0.09 (0.04)
	Medium educated			-0.15 (0.01)					0.12 (0.61)
	Low educated			0.03 (0.16)					0.00 (0.86)
Panel D									
Amenities	Estimated $\bar{\psi}_{l,2010}$				2.23 (0.00)				
	Amenity index					0.68 (0.00)			0.65 (0.00)
	Criminal offenses						-0.08 (0.02)		0.01 (0.72)
	Students per school							0.07 (0.08)	0.04 (0.31)
Adjusted R^2		0.35	0.20	0.06	0.13	0.33	0.03	0.01	0.59
N		182	182	182	182	182	182	182	182

Notes: The panels show results from regressions of estimated worker quality changes on variables varying across panels. Variation comes from differential changes across local labor markets between 1985 and 2010. Changes in worker quality are estimated according to Equation (11). Results are weighted by the number of employed workers in a market averaged across years 1985 to 2010. p-values are in parentheses. Occupations: Mgr-Prof-Tech: managers, professionals, technicians; Prod-Op-Crafts: production, operators, craftsmen; Srvc-Care: services and care. Classification of detailed occupations follows Acemoglu and Autor (2011), see Böhm et al. (2019) for the exact mapping. Industries: Machine building: manufacture of basic metals and fabricated metal products, machinery and equipment, electrical and optical equipment, transport equipment; High skill services: education, health and social, public administration and defense, compulsory social security, financial intermediation, real estate, renting and business activities, electricity, gas and water supply, other community, social and personal service activities, communication; Manufacturing: manufacture of wood and wood products, coke, refined petroleum products and nuclear fuel, chemicals; Low-skill services: hotels, restaurants, wholesale, food. Education: University degree: technical college or university; Medium educated: Abitur or apprenticeship training; Low educated: without postsecondary education or missing. Amenities: $\bar{\psi}_{l,2010}$ are the estimated amenity values according to Equation (9). The amenity index was computed by prognos (2018) combining information on 53 amenity values ranging from sunshine duration to restaurant and physician density. Data on criminal offenses comes from Bundeskriminalamt (2018). The measure was computed as offenses divided by population collected from Statistische Ämter des Bundes und der Länder (2017a). Information on students per school was retrieved from Statistische Ämter des Bundes und der Länder (2017b).

Panel A in Table 1 shows the results from a regression of the estimated changes in worker quality between 1985 and 2010 on changes in occupational (log) employment. Variation comes from differential changes in occupational employment as well as quality changes between local labor markets. Worker quality increased in regions which experienced an increase in managerial, professional and technical (Mgr-Prof-Tech) employment. In contrast, worker quality de-

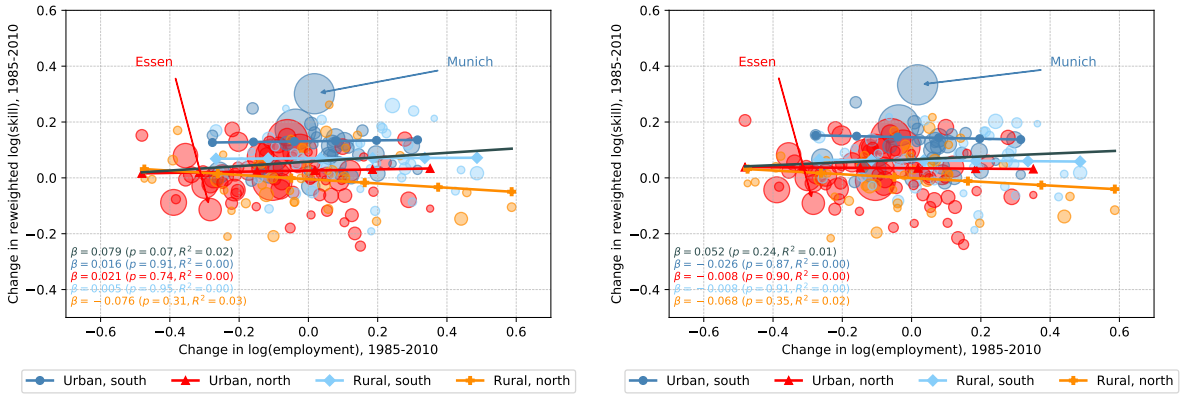
clined where low wage, service and care (Srvc-Care) employment rose as well as the number of workers employed in production, operator and crafts (Prod-Op-Crafts) occupations increased.

Similar results apply to the influence of changes in the industrial and education structure (Panels B and C). Worker quality surged where the amount of workers employed in high-skill service industries and machine building expanded as well as the number of university graduates increased . Hence, only regions which were able to "reinvent" (Glaeser, 2005) themselves through changing its employment structure where able to attract workers of high quality. These results are very similar to the findings in Findeisen and Südekum (2008).

Figure 6: Reweighted skill changes

(a) Match 1985's occupation structure

(b) Match 1985's occupation × industry structure



Notes: Figure 6a shows estimated changes in worker quality as described by Equation (11). Observations were reweighted following DiNardo et al. (1996) to eliminate differential changes in the occupation structure across local labor markets. Figure 6b repeats this by reweighting observations to eliminate differential changes in the industry times occupation structure across local labor markets. The horizontal axes depict the change in log employment between 1985 and 2010. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

To quantify the importance of changes in the occupation and industry structure, Figure 6 repeats the decomposition of changes in wages into changing wage premia and worker quality according to Equation (11). In addition to Figure 4, I reweighted observations when computing average wages to eliminate the impact of geographic differences in the number of workers employed in certain occupations, as well as industry times occupation cells, following DiNardo et al. (1996).[21] Compared to the baseline density of skill changes with respect to employment of 12 log points, both elasticities are smaller and become insignificant (p-values rise from 0.02 in

[21] Reweighting observations with education shares of 1985 does not change the elasticity at all, see Appendix Figure D.6. The reason for this is that education and employment growth are virtually uncorrelated (Appendix Figure B.5). Appendix Figure D.6 also shows the results for reweighting with industries alone instead of industry times occupation cells.

the unweighted scenario to 0.07 and 0.24). Reweighting observations with occupation shares of 1985 induces the elasticity to drop to eight log points. Further reweighting observations to match the combined occupation times industry structure of 1985 decreases the elasticity further to five log points. Overall, this shows that roughly one third to one half of the increase in skill within expanding regions is due the disproportionate growth of high paying managerial, professional and technical as well as machine building employment within expanding regions.

5.2 The Role of Local Amenities to Attract Skilled Workers

The urban economics literature has always put focus on the role of local amenities for the locational choices of the workforce and the spatial equilibrium (Glaeser and Maré, 2001; Glaeser, 2011). Here I will investigate the correlation between the estimated amenity changes as well as information on collected (time constant) amenity proxies as is also done by Diamond (2016).

Appendix Figure D.7 shows the distribution of estimated amenities, an amenity index based on information on 53 categories ranging from sunshine duration to restaurant and physician density, data on crime rates as well as students per school.[22] In general, local amenities appear to be higher in Southern than Northern Germany. This is true for both the estimated amenities as well the amenity index. Consistently, crime rates are lower in the south. In addition, the number of students per school is also lower in Southern Germany.

The results from a bivariate regression of estimated quality changes on amenities are depicted in Panel D of Table 1. Again, variation comes from differences in average skill changes and amenities across local labor markets. Regions with high estimated amenity values experienced increases in skill. The same holds for the amenity index. Contrary, areas with high crime rates exhibited lower skill growth. The relation to the number of students per school is not significant at the 5% level. This might indicate that differences in schooling quality between regions (e.g., Baumert et al., 2013) play a minor role for the variation in worker quality changes. In total, this exercise shows that regions which experienced an increase in worker quality also had higher local amenity values. An explanation for this could be the increasing sorting of high quality workers into regions with attractive living standards (Diamond, 2016).

Taking all external explanatory variables together, 59% of the variation in worker quality changes can be explained by these observables.

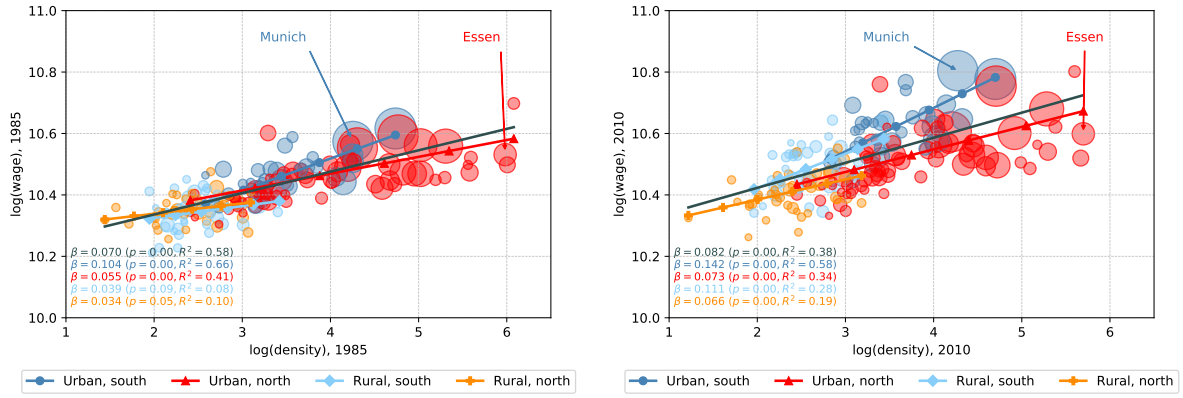
[22] The amenity index was computed by prognos (2018). Data on crime rates per person is from Bundeskriminalamt (2018). Information on students per school was retrieved from Statistische Ämter des Bundes und der Länder (2017b). Reassuringly, there is a strong positive correlation between estimated amenities $\bar{\psi}_{l,2010}$ and the amenity index (p-value < 0.01, see Appendix Figure D.8). This provides additional plausibility for the estimation approach.

6 Sources of the Rising Density Wage Premium

This section analyses the impact of changing regional wage premia and worker quality on the increasing wage disparities between German local labor markets.

Figure 7: Density wage premium increased over time

(a) Density premium 1985 (b) Density premium 2010



Notes: Figure 7a shows average wages in 1985 plotted against market density defined as number of employed workers divided by area in square kilometers. Figure 7b repeats this for 2010. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

There is a sizable wage premium which workers receive for working in more dense areas across countries (Glaeser and Maré, 2001; Combes et al., 2008; De la Roca and Puga, 2017; Dauth et al., 2019). Germany is no exception. On the contrary, the German density wage premium has even increased over time. Figure 7 shows that having worked in a 100 log point denser region (the difference in density between Munich and Göttingen) was associated with seven log points higher annual wages in 1985.[23] This elasticity increased until 2010 by roughly 17%. Is the source of that rise an increased sorting of high quality workers to dense places like Essen and Munich? Or did wage premia rise more in dense places because of higher skill demand?

Figure 8a shows the change in estimated wage premia plotted against log density in 1985. The elasticity of price changes with respect to log density is negative. A 100 log point denser region experienced a 1.8 log point lower increase in wage premia. One reason for that could be that dense areas have higher estimated amenity values and so firms in dense places do not need to pay higher wage premia to compensate workers (see Appendix Figure E.1 for the

[23] Density refers to number of employed workers in a region divided by area measured in square kilometers.

Figure 8: Changes in wage premia and worker quality by 1985's density

(a) Changes in wage premia

(b) Changes in worker quality

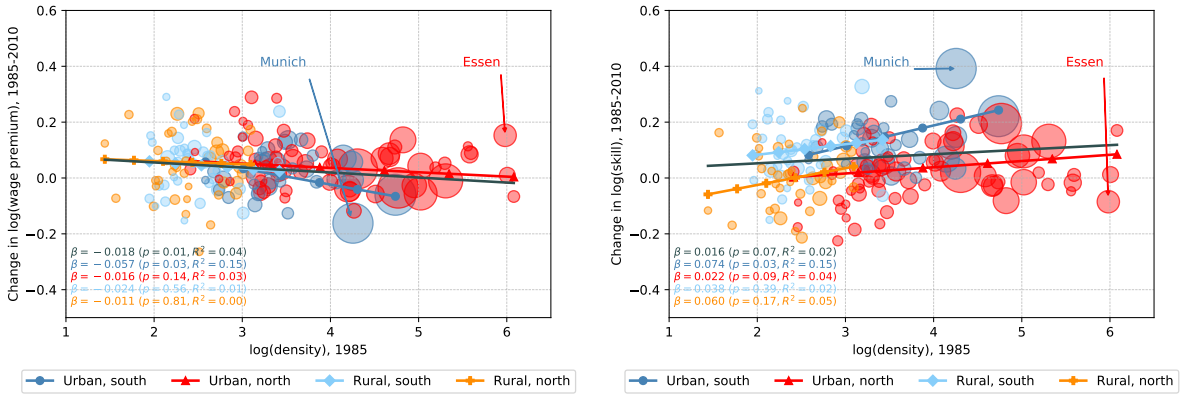


Figure 8a shows estimated changes in wage premia between 1985 and 2010. OLS estimates as described by Equation (9). Figure 8b shows estimated changes in worker quality as described by Equation (11). The horizontal axes depicts log employment density 1985 defined as number of employed workers in a market divided by area in square kilometers. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

positive correlation between estimated amenities and market density). Instead, workers might sort into dense places because of these higher amenities and give up rising wage premia they could have earned in less dense places (Roback, 1988).

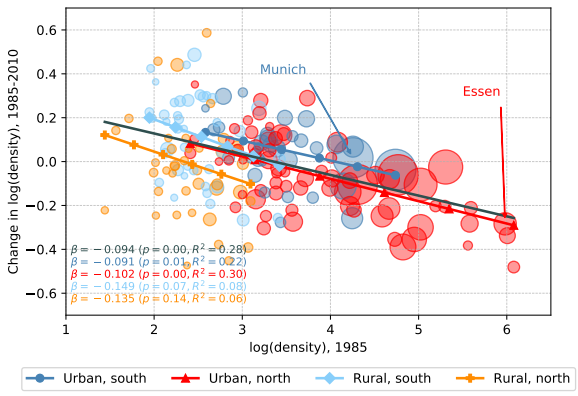
Notice, however, that the pattern of more favorable amenities in denser places does not appear with respect to the externally collected amenity data. This might indicate the necessity of identifying amenities from worker choices within a revealed preference approach instead of relying on external measures.[24] In fact, when I estimate wage premia according to Equation (9) but omit the controls for amenities, the interpretation turns around. Appendix Figure E.2 shows the results: when omitting the terms which control for local amenities, I find that denser places experienced larger increases in wage premia. This also holds when estimating changes in wage premia via year times region fixed effects while controlling for unobserved worker heterogeneity via worker times region fixed effects similar to Combes et al. (2008) or Cortes (2016). This underscores the importance of a method which is able to distinguish worker sorting because of pecuniary motives from worker sorting because of non-pecuniary motives. When ignoring the influence of amenities, estimated changes in wage premia might be biased

[24] Alternatively, this might also reflect that amenities increased more in cities and this increase has been relevant for the changing worker sorting (instead of absolute amenity values). This would not be visible (by definition) in the externally collected amenity proxies as they are time constant and refer to the values at the end of the sample period.

as workers also sort with respect to non-pecuniary aspects instead of potential wages alone. The sign of the bias, in turn, depends on the correlation between amenities and market density.

Figure 9: Changes in employment and wages by 1985's density

(a) Density declined in formerly dense areas



(b) Wage changes unrelated to 1985's densities

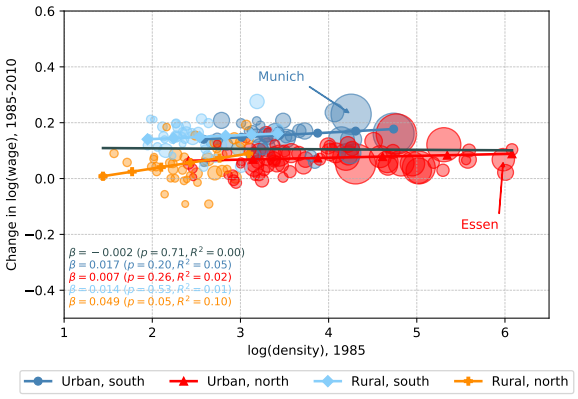


Figure 9a shows changes in employment density of a local labor market between 1985 and 2010. Figure 9b shows the change in average wages. The horizontal axes depicts log employment density 1985 defined as number of employed workers in a market divided by area in square kilometers. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

In contrast to the negative wage premium elasticity (again, which only appears when controlling for local amenities), the relation between skill changes and density is positive (Figure 8b). A 100 log point denser region experienced a 1.6 log point higher increase in worker quality. This effect thereby almost exactly offset the relative decline in wage premia within dense areas.

If changes in wage premia and worker quality balanced each other, why then did the density premium increase over time? The reason for this is that employment in dense German regions did not rise further. On the one hand, previously dense places such as the Ruhrgebiet including Essen lost large fractions of their employment force as shown in Figure 9a. On the other hand, many less dense areas – mainly in southern Germany – gained employment and so became denser over time. In combination with almost density independent changes in average wages (see Figure 9b showing the sum of Figures 8a and 8b for completeness), this made the slope of the density wage premium become steeper over time. Therefore, the rise in the premium is mainly because of declining employment in the formerly densest areas as well as expanding employment in previously less dense places. Changes in wage premia and changes in worker quality, however, have offset each other on average across markets of different dens-

ity.

7 Conclusion

There has been considerable variation in wage and employment changes across German local labor markets during the last few decades. Whereas southern regions experienced both an increase in wages and employment on average, the opposite was true for many northern regions. This resulted in a strong connection between wage and employment growth across markets, seemingly consistent with geographic differences in shocks to demand. This paper has investigated the drivers of these opposing trends in more detail: did demand increase relatively more in regions with growing employment? Or did worker quality improve in expanding areas?

To separate these two competing explanations, I have estimated selection corrected local wage premia paid for a unit of skill as well as differences in local amenities within a generalized Roy model setting. In that framework, workers decide in what region to work in based on latent, potential real wages and local amenities. The model was informed by variation in workers' wage growth and their location decisions including workers' moving behavior.

The results have shown that, contrary to average wages, quality adjusted wage premia have not increased more in expanding regions. That is, the increase in wage premia workers get paid for their skills was roughly the same in growing and shrinking local labor markets. Instead, the quality of workers employed in regions with expanding employment improved. This resulted in comparably high wage growth within these regions.

I have investigated several potential explanations for this finding by comparing observables of regions with growing worker quality to the observables of regions with declining skill. Worker quality improved in regions which were able to attract professional and technical occupations as well as firms engaged in the machine building sector. This primarily happened in Southern Germany; a region which was able to "reinvent" itself over time (Findeisen and Südekum, 2008). Average skill also increased in regions with high estimated amenity values. This suggests that skilled workers might sort into regions with attractive living standards although local prices might be higher in these areas as well (Diamond, 2016); a possibility for which I control in the estimation.

Last, I have explored the determinants of the rising market density premium. I found that worker quality has increased more in dense places. This effect, however, was offset by a relative decline in wage premia of dense places. A potential explanation for that might be the

rising importance of amenities in the location decisions of workers and their wage compensating nature. In line, dense places have higher estimated amenity values in the estimation. This pattern does not appear with respect to external data on amenity values, however.

Further disentangling possible mechanisms which influence the sorting of skill across space is a fruitful topic for future research and policy. The answer to the question about how local labor markets can attract skilled workers and successful firms is of first order importance in a world of rising disparities (Arntz, 2010; Moretti, 2012); especially in the light of increasing political polarization between regions because of regional differences in the vulnerability to technical change and competition from abroad (Autor et al., 2016).

Additionally, it would be interesting to investigate possible sources for spatial differences in occupational and industrial change. In a first step, one might therefore estimate how the returns to occupational skill have changed over time and across regions. For instance, Manning and Petrongolo (2017) show that local labor markets are indeed quite local and so should be the returns to skill. Holding the composition of skill constant, such an exercise would then also allow to investigate possible sources of changing occupational skill prices by exploiting additional variation across local labor markets. Such regional variation could range from market thickness in the supply of potential skill (Bleakley and Lin, 2012) to technology investments (Czernich et al., 2011).

References

ABOWD, J. M., F. KRAMARZ, AND D. N. MARGOLIS (1999): "High wage workers and high wage firms," *Econometrica*, 67, 251–333.

ACEMOGLU, D. AND D. H. AUTOR (2011): "Skills, Tasks and Technologies: Implications for Employment and Earnings," in *Handbook of Labor Economics, vol. 4 Part B*, ed. by D. Card and O. Ashenfelter, Elsevier, chap. 12, 1043–1171.

AMIOR, M. AND A. MANNING (2018): "The Persistence of Local Joblessness," *American Economic Review*, 108, 1942–1970.

ARNTZ, M. (2010): "What Attracts Human Capital? Understanding the Skill Composition of Interregional Job Matches in Germany," *Regional Studies*, 44, 423–441.

AUTOR, D. (2019): "Work of the Past, Work of the Future," in *Richard T. Ely Lecture given at Annual Meeting of American Economics Association, Atlanta, GA, January*, vol. 4.

AUTOR, D., D. DORN, G. HANSON, AND K. MAJLESI (2016): "Importing political polarization? The electoral consequences of rising trade exposure," Working Paper 22637, NBER.

BÁRÁNY, Z. AND C. SIEGEL (2018): "Job Polarization and Structural Change," *American Economic Journal: Macroeconomics*, 10, 59–89.

BAUMERT, J., C. ARTELT, E. KLIEME, M. NEUBRAND, M. PRENZEL, U. SCHIEFELE, W. SCHNEIDER, K.-J. TILLMANN, AND M. WEISS (2013): *PISA 2000—Die Länder der Bundesrepublik Deutschland im Vergleich*, Springer-Verlag.

BBSR (2014): "Bundesinstitut für Bau-, Stadt- und Raumforschung: Raumabgrenzungen," URL: https://www.bbsr.bund.de/BBSR/DE/Raumbeobachtung/Downloads/downloads_node.html.

BERRY, C. R. AND E. L. GLAESER (2005): "The divergence of human capital levels across cities," *Papers in Regional Science*, 84, 407–444.

BLANCHARD, O. J. AND L. F. KATZ (1992): "Regional Evolutions," *Brookings Papers on Economic Activity*, 1992, 1–75.

BLEAKLEY, H. AND J. LIN (2012): "Thick-Market Effects and Churning in the Labor Market: Evidence from US Cities," *Journal of Urban Economics*, 72, 87 – 103.

BÖHM, M., H.-M. VON GAUDECKER, AND F. SCHRAN (2019): "Occupation Growth, Skill Prices, and Wage Inequality," Working Paper.

BOUND, J. AND H. J. HOLZER (2000): "Demand Shifts, Population Adjustments, and Labor Market Outcomes During the 1980s," *Journal of Labor Economics*, 18, 20–54.

BUNDESKRIMINALAMT (2018): "Polizeiliche Kriminalstatistik, PKS 2018 - BKA (Länder-, Kreis- und Städte) Übersicht Falltabellen," URL: https://www.bka.de/DE/AktuelleInformationen/StatistikenLagebilder/PolizeilicheKriminalstatistik/PKS2018/BKATabellen/bkaTabellenLaenderKreiseStaedteFaelle.html?nn=108686.

CARD, D., J. HEINING, AND P. KLINE (2013): "Workplace Heterogeneity and the Rise of West German Wage Inequality," *Quarterly Journal of Economics*, 128, 967–1015.

COMBES, P.-P., G. DURANTON, AND L. GOBILLON (2008): "Spatial Wage Disparities: Sorting Matters!" *Journal of Urban Economics*, 63, 723–742.

COMBES, P.-P., G. DURANTON, L. GOBILLON, AND S. ROUXE (2012): "Sorting and local wage and skill distributions in France," *Regional Science and Urban Economics*, 42, 913–930.

CORTES, G. M. (2016): "Where Have the Middle-Wage Workers Gone? A Study of Polarization Using Panel Data," *Journal of Labor Economics*, 34, 63–105.

CZERNICH, N., O. FALCK, T. KRETSCHMER, AND L. WOESSMANN (2011): "Broadband infrastructure and economic growth," *The Economic Journal*, 121, 505–532.

DAHL, G. B. (2002): "Mobility and the Return to Education: Testing a Roy Model with Multiple Markets," *Econometrica*, 70, 2367–2420.

DAUTH, W., S. FINDEISEN, E. MORETTI, AND J. SÜDEKUM (2019): "Matching in Cities," IZA Discussion Paper No. 12278.

DAUTH, W., S. FINDEISEN, AND J. SÜDEKUM (2017): "Trade and Manufacturing Jobs in Germany," *American Economic Review: Papers & Proceedings*, 107, 337–342.

D'COSTA, S. AND H. G. OVERMAN (2014): "The Urban Wage Growth Premium: Sorting or Learning?" *Regional Science and Urban Economics*, 48, 168–179.

DE LA ROCA, J. AND D. PUGA (2017): "Learning by Working in Big Cities," *Review of Economic Studies*, 84, 106–142.

DIAMOND, R. (2016): "The Determinants and Welfare Implications of US Workers' Diverging Location Choices by Skill: 1980-2000," *American Economic Review*, 106, 479–524.

DINARDO, J., N. M. FORTIN, AND T. LEMIEUX (1996): "Labor Market Institutions and the Distribution of Wages, 1973-1992: A Semiparametric Approach," *Econometrica*, 64, 1001–1044.

DURANTON, G. (2007): "Urban Evolutions: The Fast, the Slow, and the Still," *American Economic Review*, 97.

DURANTON, G. AND D. PUGA (2004): "Micro-foundations of Urban Agglomeration Economies," in *Handbook of Regional and Urban Economics*, Elsevier, vol. 4, 2063–2117.

DUSTMANN, C. AND A. GLITZ (2015): "How do Industries and Firms Respond to Changes in Local Labor Supply?" *Journal of Labor Economics*, 33, 711–750.

DUSTMANN, C., J. LUDSTECK, AND U. SCHÖNBERG (2009): "Revisiting the German wage structure," *Quarterly Journal of Economics*, 124, 843–881.

EECKHOUT, J., R. PINHEIRO, AND K. SCHMIDHEINY (2014): "Spatial Sorting," *Journal of Political Economy*, 122, 554–620.

FINDEISEN, S. AND J. SÜDEKUM (2008): "Industry Churning and the Evolution of Cities: Evidence for Germany," *Journal of Urban Economics*, 64, 326 – 339.

FITZENBERGER, B., A. OSIKOMINU, AND R. VÖLTER (2006): "Imputation Rules to Improve the Education Variable in the IAB Employment Subsample," *Schmollers Jahrbuch(Journal of the Applied Social Sciences)*, 126, 405–436.

GANZER, A., A. SCHMUCKER, P. VOM BERGE, AND A. WURDACK (2017): "Sample of Integrated Labour Market Biographies – Regional File 1975-2014 (SIAB-R 7514)," Tech. Rep. 1, FDZ–Datenreport.

GLAESER, E. L. (1999): "Learning in Cities," *Journal of Urban Economics*, 46, 254–277.

——— (2005): "Reinventing Boston: 1630–2003," *Journal of Economic Geography*, 5, 119–153.

——— (2008): *Cities, Agglomeration, and Spatial Equilibrium*, Cambridge, UK: Oxford University Press.

——— (2011): *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier and Happier*, New York, NY: Penguin Press.

GLAESER, E. L. AND J. D. GOTTLIEB (2008): "The Economics of Place-Making Policies," *Brookings Papers on Economic Activ-ity*, 1, 155–253.

GLAESER, E. L., J. KOLKO, AND A. SAIZ (2001): "Consumer City," *Journal of Economic Geography*, 1, 27–50.

GLAESER, E. L. AND D. C. MARÉ (2001): "Cities and Skills," *Journal of Labor Economics*, 19, 316–342.

HECKMAN, J. J., L. LOCHNER, AND C. TABER (1998): "Explaining Rising Wage Inequality: Explorations with a Dynamic General Equilibrium Model of Labor Earnings with Heterogeneous Agents," *Review of Economic Dynamics*, 1, 1–58.

HSIEH, C.-T., E. HURST, C. I. JONES, AND P. J. KLENOW (forthcoming): "The Allocation of Talent and U.S. Economic Growth," *Econometrica*.

KAWKA, R., S. BEISSWENGER, G. COSTA, H. KEMMERLING, S. MÜLLER, T. PÜTZ, H. SCHMIDT, S. SCHMIDT, AND M. TRIMBORN (2009): "Regionaler Preisindex, Berichte Band 30," Tech. rep., Bundesinstitut für Bau-, Stadt- und Raumforschung, Bonn, uRL: https://www.bbsr.bund.de/BBSR/DE/Veroeffentlichungen/Abgeschlossen/Berichte/2009_2010/Bd30RegPreisindex.html.

KLINE, P. AND E. MORETTI (2014): "People, Places, and Public Policy: Some Simple Welfare Economics of Local Economic Development Programs," *Annual Review of Economics*, 6, 629–662.

KROPP, P. AND B. SCHWENGLER (2011): "Abgrenzung von Arbeitsmarktregionen - ein Methodenvorschlag," *Raumforschung und Raumordnung*, 1, 45–62.

MANNING, A. AND B. PETRONGOLO (2017): "How Local are Labor Markets? Evidence from a Spatial Job Search Model," *American Economic Review*, 107, 2877–2907.

MORETTI, E. (2012): *The New Geography of Jobs*, Houghton Mifflin Harcourt.

——— (2013): "Real Wage Inequality," *American Economic Journal: Applied Economics*, 5, 65–103.

PROGNOS (2018): "Hintergrund zur Großen ZDF-Deutschland-Studie," Tech. rep., prognos AG, Berlin, uRL: http://deutschlandstudie.prognos.com/fileadmin/Dokumente/kdjbvkjsdbvlasdjvlaihsdfdaihfaihdgfih1isdfhvai4/Hintergrund-PDF_Deutschlandstudie_Mai_2018.

ROBACK, J. (1988): "Wages, Rents, and Amenities: Differences Among Workers and Regions," *Economic Inquiry*, 26, 23–41.

ROSEN, S. (1986): "The theory of equalizing differences," in *Handbook of Labor Economics*, ed. by O. Ashenfelter and R. Layard, Elsevier, vol. 1, chap. 12, 641 – 692.

ROY, A. D. (1951): "Some Thoughts on the Distribution of Earnings," *Oxford Economic Papers*, 3, 135–146.

SÜDEKUM, J. (2008): "Convergence of the skill composition across German regions," *Regional Science and Urban Economics*, 38, 148 – 159.

SORKIN, I. (2018): "Ranking Firms Using Revealed Preference," *Quarterly Journal of Economics*, 133, 1331–1393.

STATISTISCHE ÄMTER DES BUNDES UND DER LÄNDER (2017a): "Regionaldatenbank Deutschland: Fortschreibung des Bevölkerungsstandes," URL: https://www.regionalstatistik.de/genesis/online/data;jsessionid=63B2B49818074223523B1E3FABD6039A.reg2?operation=previous&levelindex=3&levelid=1558971972857&levelid=1558971948778&step=2.

——— (2017b): "Regionaldatenbank Deutschland: Statistik der allgemeinbildenden Schulen," URL: https://www.regionalstatistik.de/genesis/online/data;jsessionid=69E491BC7F859D12B21C590C0D19D109.reg2?operation=abruftabelleAbrufen&selectionname=21111-01-03-4&levelindex=1&levelid=1558971361255&index=1.

WHEATON, W. C. (1979): "Metropolitan Growth, Unemployment, and Interregional Factor Mobility," in *Interregional Movements and Regional Growth*, ed. by W. C. Wheaton, Urban Institute, 237 – 253.

WHEELER, C. H. (2006): "Cities and the Growth of Wages Among Young Workers: Evidence from the NLSY," *Journal of Urban Economics*, 60, 162–184.

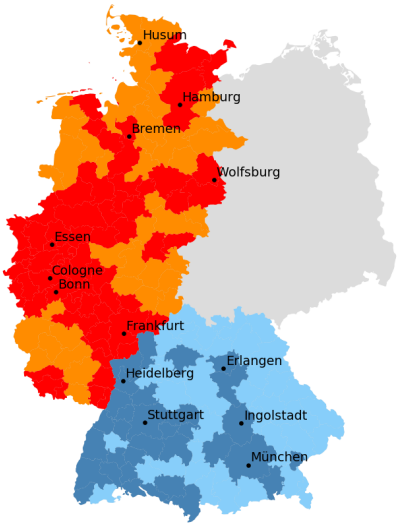
YAMAGUCHI, S. (2018): "Changes in Returns to Task-Specific Skills and Gender Wage Gap," *Journal of Human Resources*, 53, 32–70.

A Data Appendix

A.1 Aggregation of Local Labor Markets

Assignment of political districts to West German local labor markets is based on commuting flows and follows Kropp and Schwengler (2011). East Germany is left out of the analysis. Local labor markets are further classified into the groups: urban - north (red), rural - north (orange), urban - south (darkblue) and rural - south (lightblue). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Figure A.1 shows the classification across Germany.

Figure A.1: Spatial distribution of rural and urban Regions



A.2 Aggregation of Occupations

Occupations are categorized into:

1. Managers-Professionals-Technicians (Mgr-Prof-Tech)
2. Sales-Office (Sales-Office)
3. Production-Operators-Craftsmen (Prod-Op-Crafts)
4. Services-Care (Srvc-Care)

Classification of detailed occupations follows Acemoglu and Autor (2011), see Böhm et al. (2019) for the exact mapping.

A.3 Aggregation of Industries

Machine building: manufacture of basic metals and fabricated metal products, machinery and equipment, electrical and optical equipment, transport equipment; High skill services: education, health and social, public administration and defense, compulsory social security, financial intermediation, real estate, renting and business activities, electricity, gas and water

supply, other community, social and personal service activities, communication; Manufacturing: manufacture of wood and wood products, coke, refined petroleum products and nuclear fuel, chemicals; Low-skill services: hotels, restaurants, wholesale, food. This largely follows Bárány and Siegel (2018) with the additional differentiation between manufacturing and machine building as, compared to other countries, Germany has a very large and increasing share of machine building firms (Dauth et al., 2017).

A.4 Education

University degree: technical college or university; Medium educated: Abitur or apprenticeship training; Low educated: without postsecondary education or missing. This classification follows Fitzenberger et al. (2006).

A.5 Amenity Data

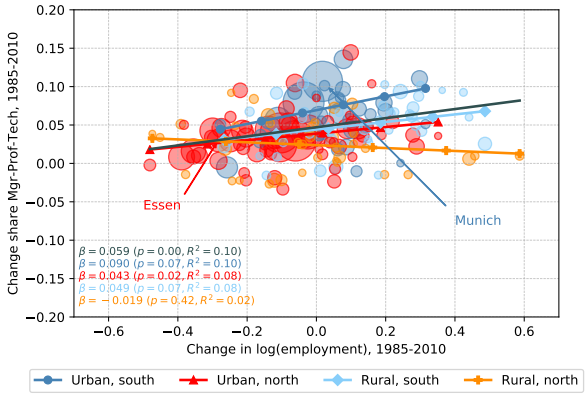
The amenity index was computed by prognos (2018) combining information on 53 amenity values ranging from sunshine duration to restaurant and physician density. Data on criminal offenses comes from Bundeskriminalamt (2018). The measure was computed as offenses divided by population collected from Statistische Ämter des Bundes und der Länder (2017a). Information on students per school was retrieved from Statistische Ämter des Bundes und der Länder (2017b). Data on a local price index comes from Kawka et al. (2009). Local price differences correspond to 2006 – 2008.

B Observables of Growing Regions

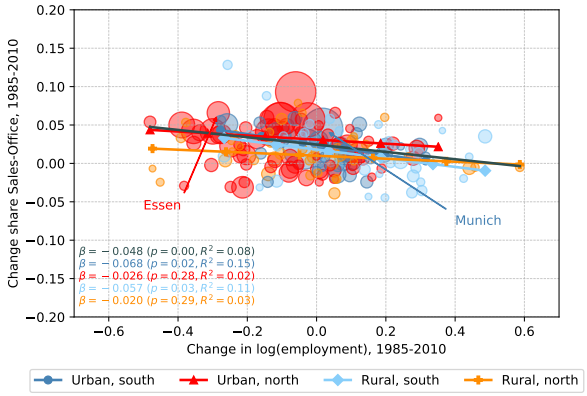
B.1 Occupation Growth

Figure B.1: Changes of occupational employment

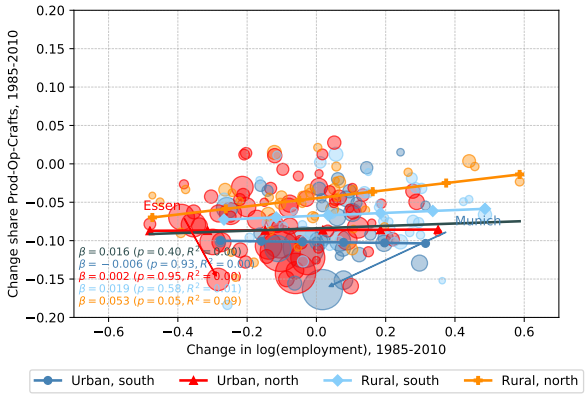
(a) Mgr-Prof-Tech



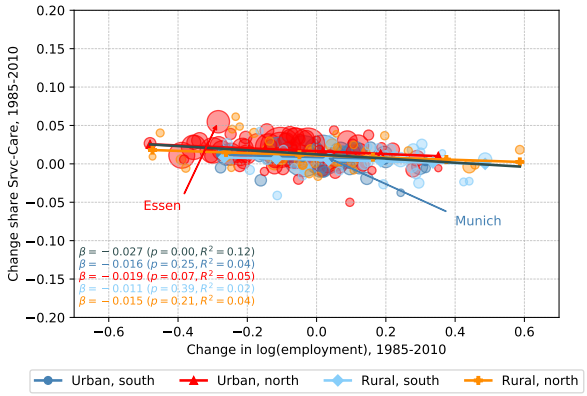
(b) Sales-Office



(c) Prod-Op-Crafts

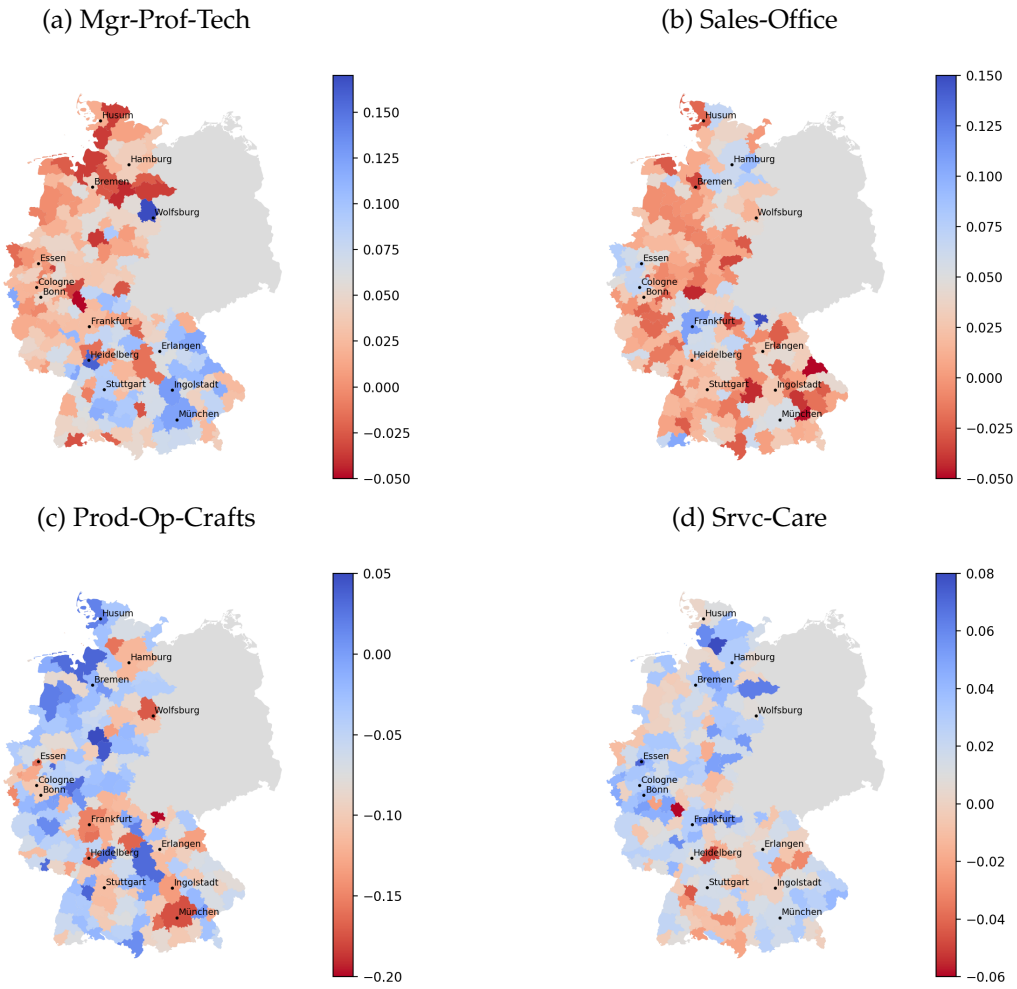


(d) Srvc-Care



Notes: The vertical axes show changes in occupational employment shares between 1985 and 2010. The horizontal axes depict the change in log employment between 1985 and 2010. Mgr-Prof-Tech: managers, professionals, technicians; Prod-Op-Crafts: production, operators, craftsmen; Srvc-Care: services and care. Classification of detailed occupations follows Acemoglu and Autor (2011), see Böhm et al. (2019) for the exact mapping. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

Figure B.2: Changes of occupational employment across space



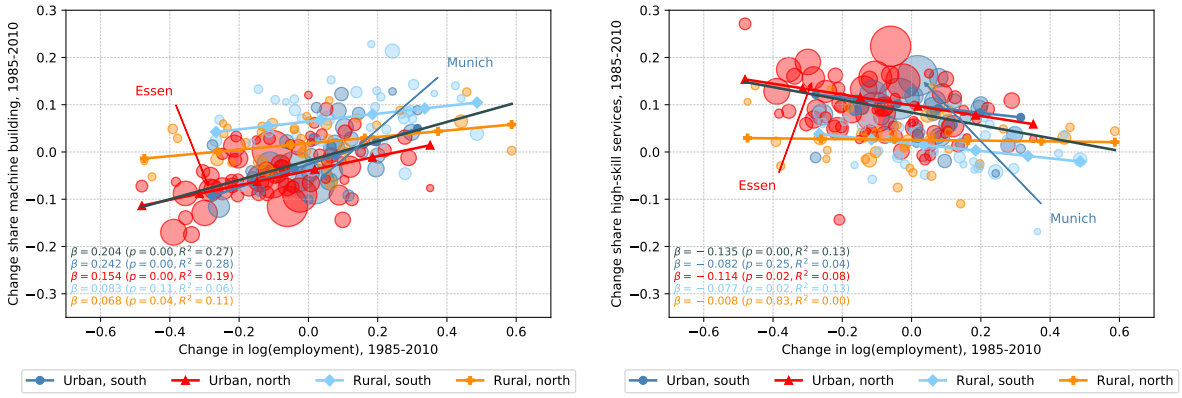
Notes: The maps show changes in occupational employment shares between 1985 and 2010 across space. Mgr-Prof-Tech: managers, professionals, technicians; Prod-Op-Crafts: production, operators, craftsmen; Srvc-Care: services and care. Classification of detailed occupations follows Acemoglu and Autor (2011), see Böhm et al. (2019) for the exact mapping. Assignment of political districts to West German local labor markets is based on commuting flows and follows Kropp and Schwengler (2011). East Germany is left out of the analysis.

B.2 Industry Growth

Figure B.3: Changes of industrial employment

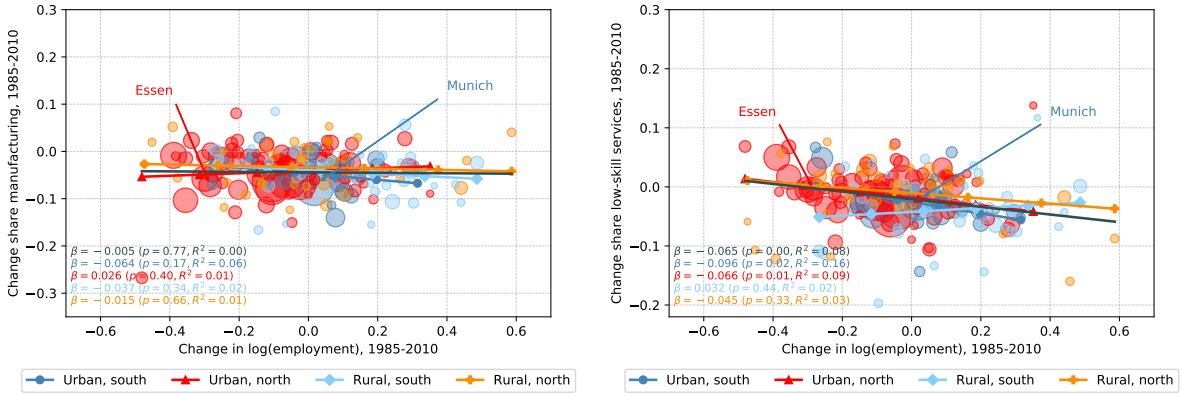
(a) Machine building

(b) High-skill services



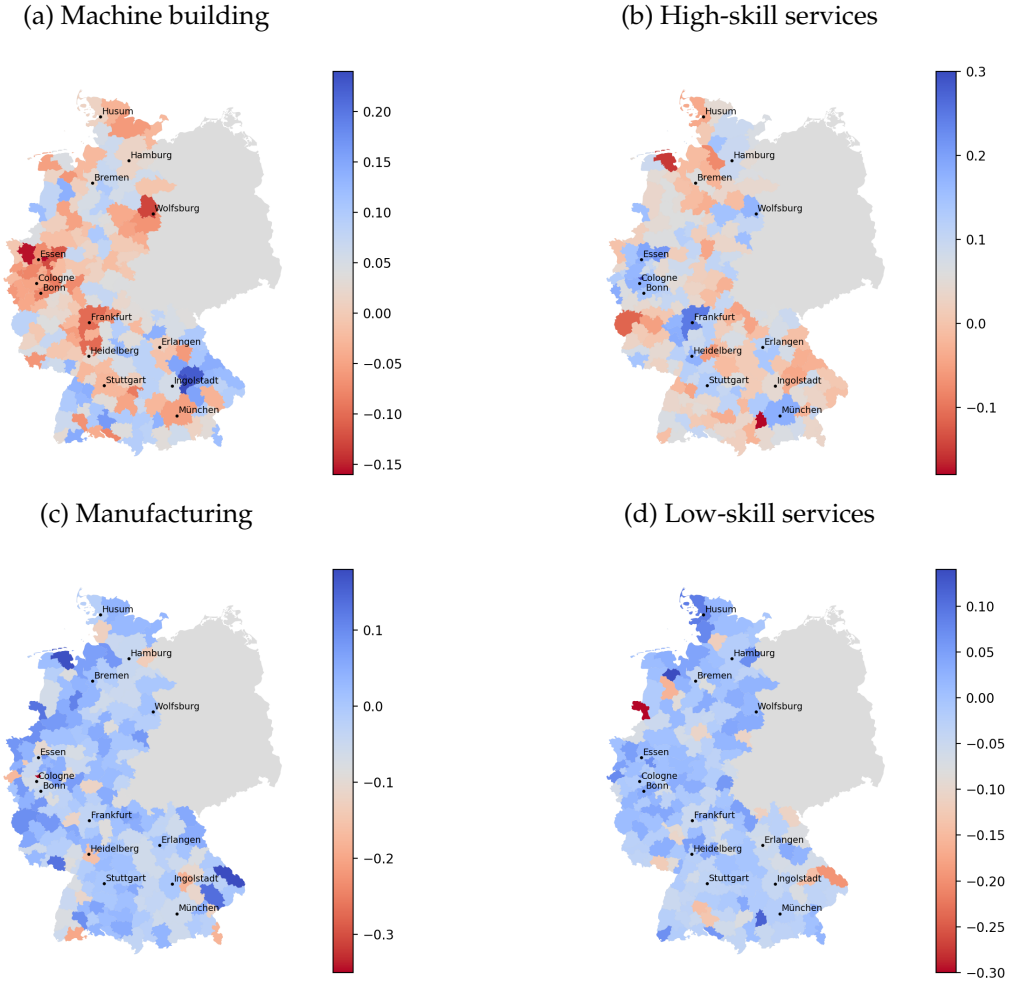
(c) Manufacturing

(d) Low-skill services



Notes: The vertical axes show changes in industrial employment shares between 1985 and 2010. The horizontal axes depict the change in log employment between 1985 and 2010. Machine building: manufacture of basic metals and fabricated metal products, machinery and equipment, electrical and optical equipment, transport equipment; High skill services: education, health and social, public administration and defense, compulsory social security, financial intermediation, real estate, renting and business activities, electricity, gas and water supply, other community, social and personal service activities, communication; Manufacturing: manufacture of wood and wood products, coke, refined petroleum products and nuclear fuel, chemicals; Low-skill services: hotels, restaurants, wholesale, food. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

Figure B.4: Changes of industrial employment across space

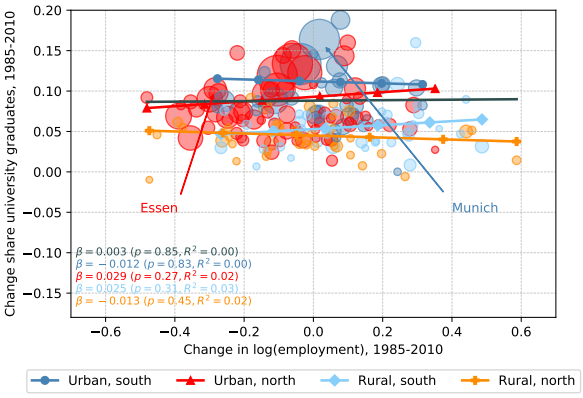


Notes: The maps show changes in industrial employment shares between 1985 and 2010 across space. Machine building: manufacture of basic metals and fabricated metal products, machinery and equipment, electrical and optical equipment, transport equipment; High skill services: education, health and social, public administration and defense, compulsory social security, financial intermediation, real estate, renting and business activities, electricity, gas and water supply, other community, social and personal service activities, communication; Manufacturing: manufacture of wood and wood products, coke, refined petroleum products and nuclear fuel, chemicals; Low-skill services: hotels, restaurants, wholesale, food. Assignment of political districts to West German local labor markets is based on commuting flows and follows Kropp and Schwengler (2011). East Germany is left out of the analysis.

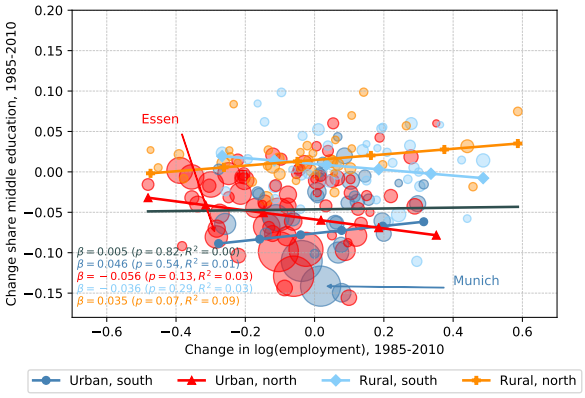
B.3 Educational Changes

Figure B.5: Changes of education shares

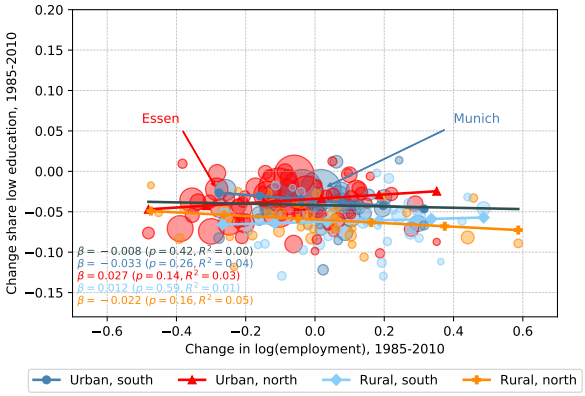
(a) University degree



(b) Medium educated



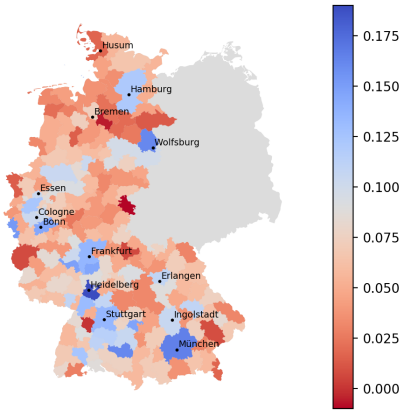
(c) Low educated



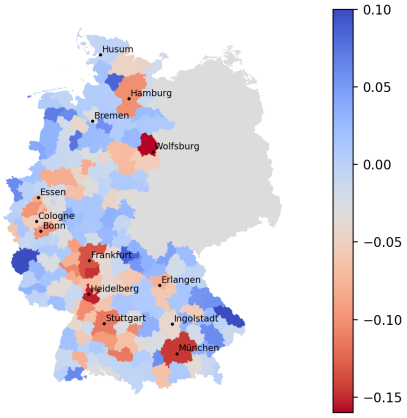
Notes: The vertical axes show changes in education shares between 1985 and 2010. The horizontal axes depict the change in log employment between 1985 and 2010. University degree: technical college or university; Medium educated: Abitur or apprenticeship training; Low educated: without postsecondary education or missing. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

Figure B.6: Changes of education shares across space

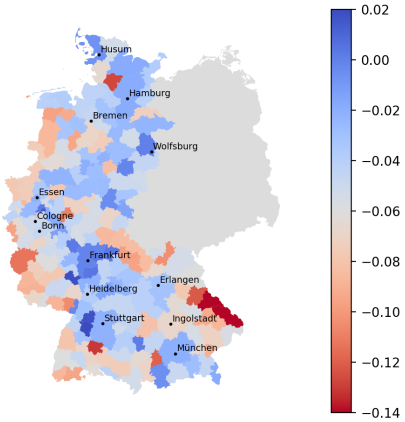
(a) University degree



(b) Medium educated



(c) Low educated



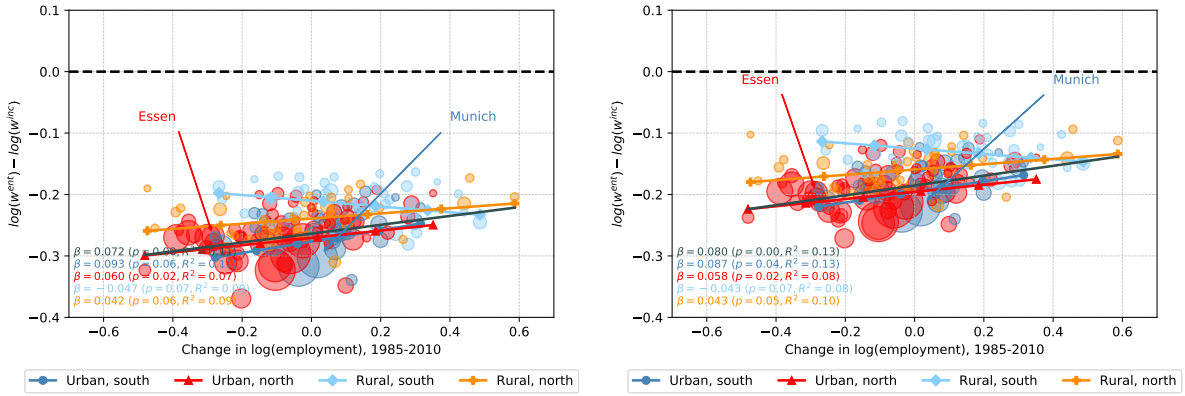
Notes: The maps show changes in education shares between 1985 and 2010 across space. University degree: technical college or university; Medium educated: Abitur or apprenticeship training; Low educated: without postsecondary education or missing. Assignment of political districts to West German local labor markets is based on commuting flows and follows Kropp and Schwengler (2011). East Germany is left out of the analysis.

B.4 Entrants' wages

Figure B.7: Wages of regional entrants minus wages of incumbents

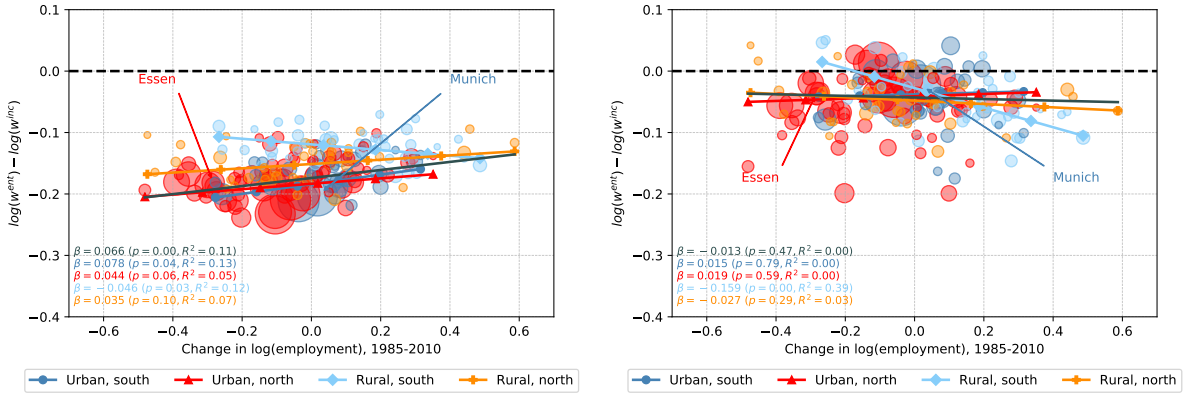
(a) Raw

(b) Conditional on age, education



(c) Conditional on age, education, occupation

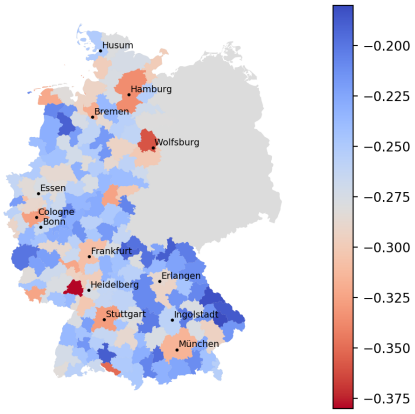
(d) Entrant = switcher from another region



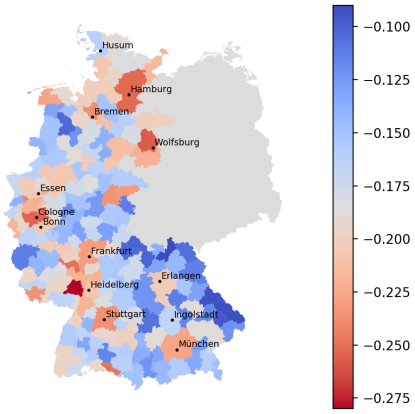
Notes: The vertical axis in Panel B.7a shows the average wage of an entrant to a region relative to the average wage of incumbents in that region. The vertical axis in Panel B.7b shows the (relative) residual wage of entrants after a regression on age and education dummies. Panel B.7c repeats this and additionally adds occupation dummies to the regression. The vertical axis in Panel B.7d shows the average wage of a mover from another local labor market relative to the average wage of incumbents in the destination region. Averages are taken across years 1985 until 2010. The horizontal axes depict the change in log employment between 1985 and 2010. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

Figure B.8: Entrants' relative wages across space

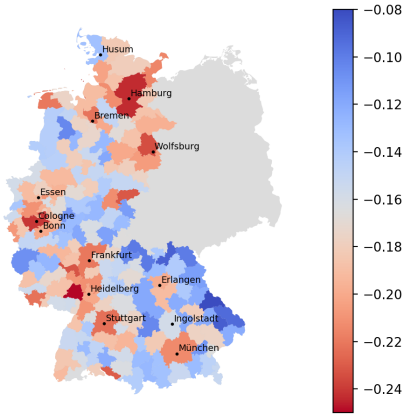
(a) Raw



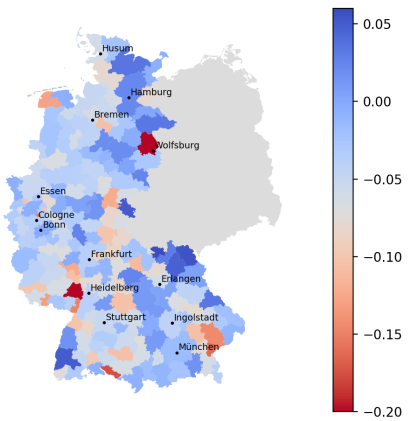
(b) Conditional on age, education



(c) Conditional on age, education, occupation



(d) Entrant = switcher from another region

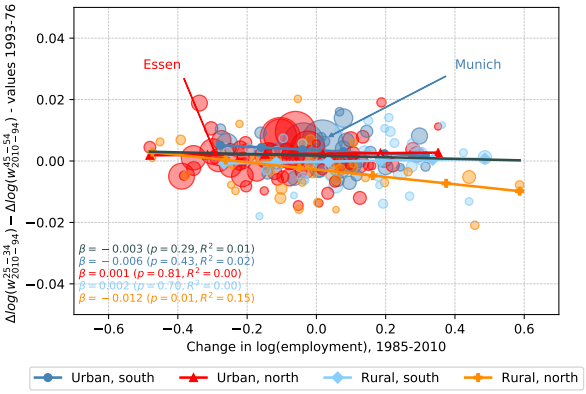


Notes: The map in Panel B.8a shows the average wage of an entrant to a region relative to the average wage of incumbents in that region. The map in Panel B.8a shows the (relative) residual wage of entrants after a regression on age and education dummies. Panel B.8a repeats this and additionally adds occupation dummies to the regression. The map in Panel B.8a shows the average wage of a mover from another local labor market relative to the average wage of incumbents in the destination region. Averages are taken across years 1985 until 2010. Assignment of political districts to West German local labor markets is based on commuting flows and follows Kropp and Schwengler (2011). East Germany is left out of the analysis.

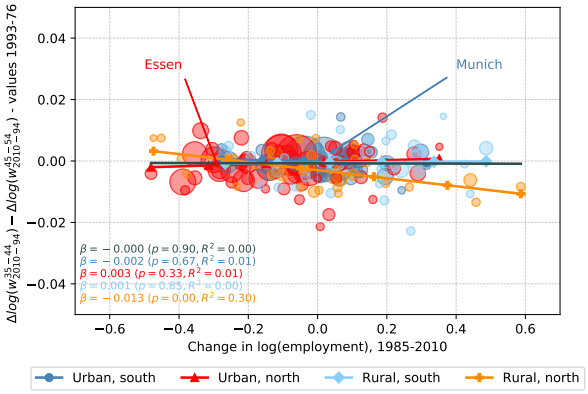
C Additional Results for Section 4.2

Figure C.1: Wage growth between age groups

(a) [25, 34] year olds - [44, 54]



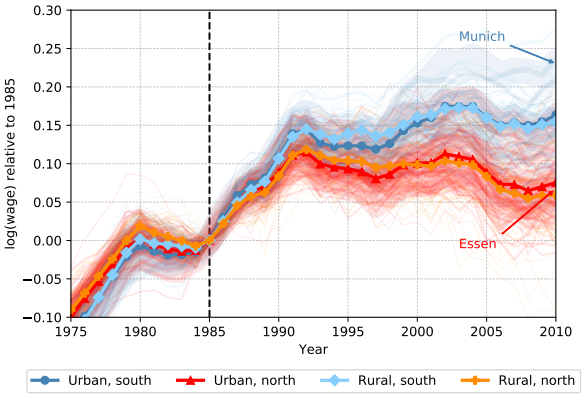
(b) [35, 44] year olds - [44, 54]



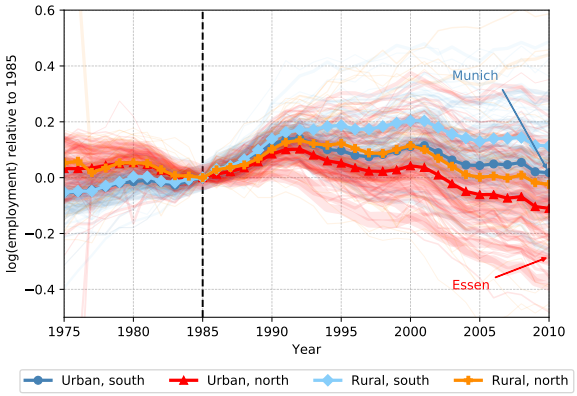
Notes: The figures show a triple difference-in-difference result: how much has wage growth of young (Figure C.1a) and medium old (Figure C.1b) workers relative to the wage growth of old workers changed after 1993 relative to 1993 and before? The horizontal axes depict the change in log employment between 1985 and 2010. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

Figure C.2: Changes in employment and wages including base period

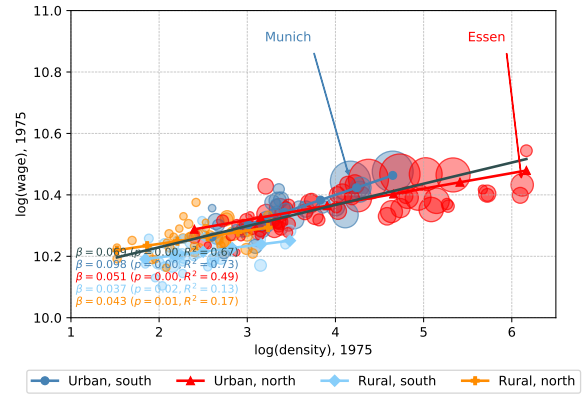
(a) Wage changes over time



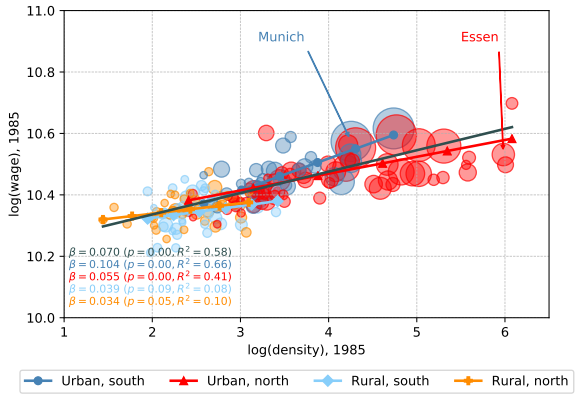
(b) Employment changes over time



(c) Density premium 1975



(d) Density premium 1985



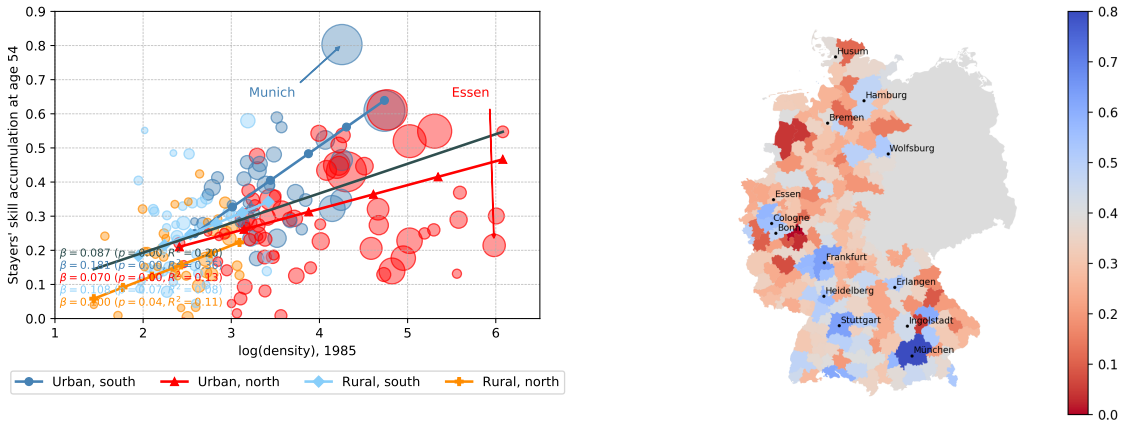
Notes: Figure C.2a shows the change in log wages within local labor markets over time. Figure C.2b shows the change in log employment. Shaded lines in the background represent 182 West German detailed local labor markets. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). The thickness of a shaded background line corresponds to the number of employed workers in a local labor market averaged across years 1985 until 2010. Figure C.2c shows average wages in 1975 plotted against market density defined as number of employed workers divided by area in square kilometers. Figure C.2d repeats this for 1985. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

D Additional Results for Section 5

Figure D.1: Skill accumulation

(a) Dense places have higher skill accumulation

(b) Skill accumulation across space

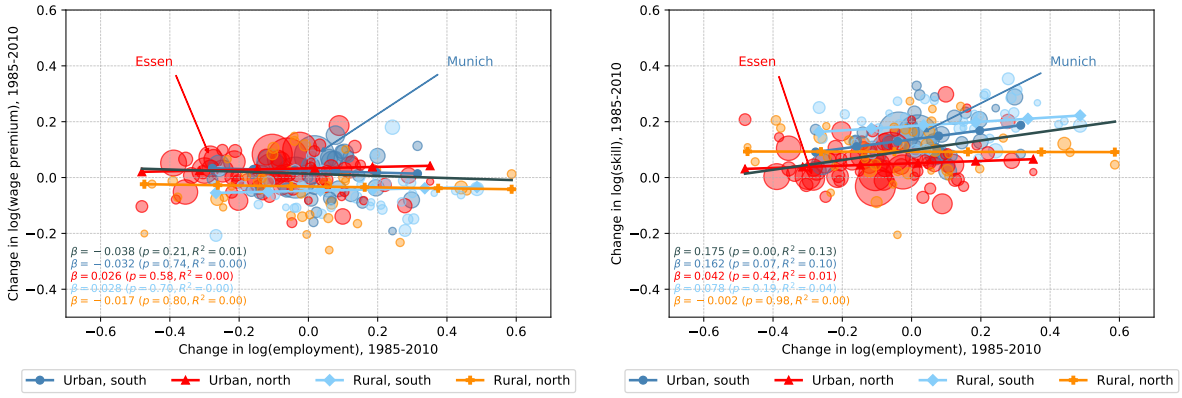


Notes: Figure D.1a shows estimated skill accumulation rates $\Gamma_{l,l}$ for a hypothetical market stayer at age 54. OLS estimates as described by Equation (9). The horizontal axis depicts log employment density 1985 defined as number of employed workers in a market divided by area in square kilometers. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers. Figure D.1b plots estimated skill accumulation rates across Germany. Assignment of political districts to West German local labor markets is based on commuting flows and follows Kropp and Schwengler (2011). East Germany is left out of the analysis.

Figure D.2: Omitting controls for changes in amenities

(a) Changes in wage premia

(b) Changes in worker quality

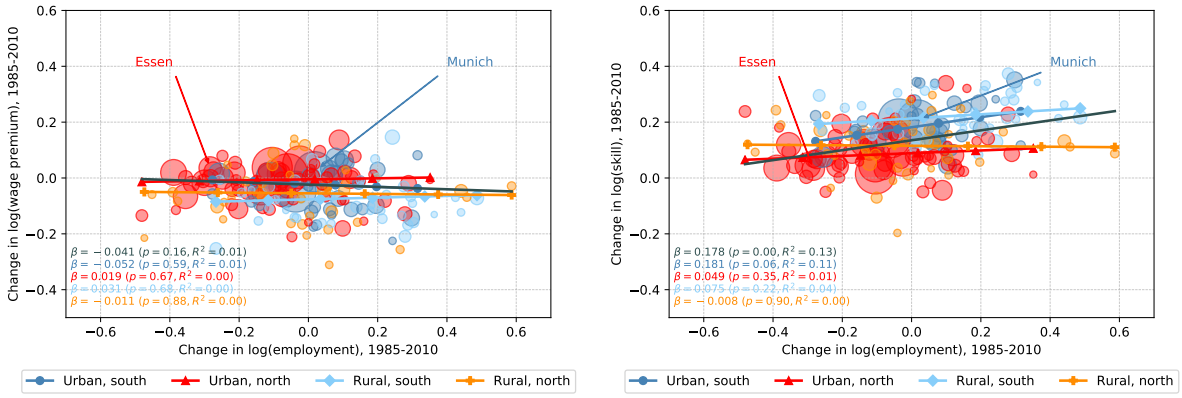


Notes: Figure D.2a shows estimated changes in wage premia between 1985 and 2010. OLS estimates as described by Equation (9) but omitting controls for changing amenities. Figure D.2b shows estimated changes in worker quality as described by Equation (11) again omitting controls for changing amenities. The horizontal axes depict the change in log employment between 1985 and 2010. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

Figure D.3: Education dependent skill accumulation function

(a) Changes in wage premia

(b) Changes in worker quality

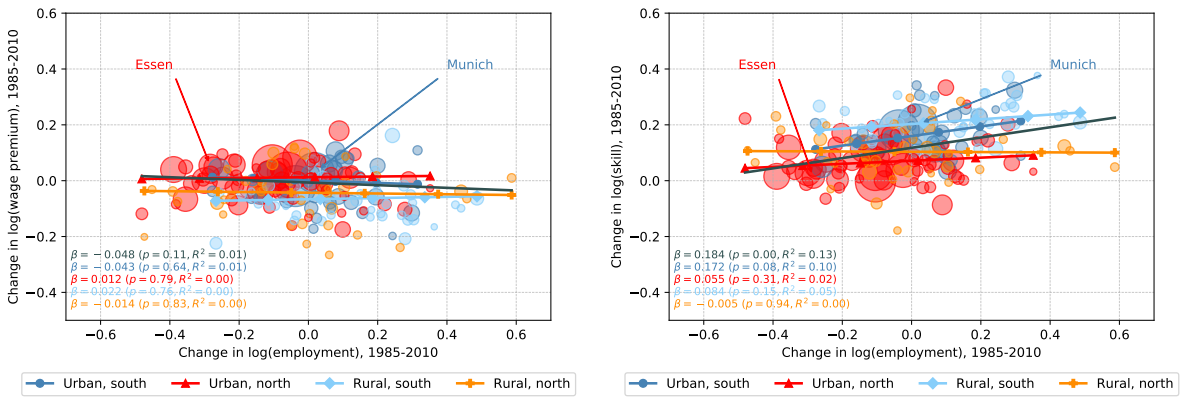


Notes: Figure D.3a shows estimated changes in wage premia between 1985 and 2010. OLS estimates as described by Equation (9) but omitting controls for changing amenities. Additionally, speed of skill accumulation depends on three education groups. University degree: technical college or university; Medium educated: Abitur or apprenticeship training; Low educated: without postsecondary education or missing. Figure D.3b shows estimated changes in worker quality as described by Equation (11) again omitting controls for changing amenities. The horizontal axes depict the change in log employment between 1985 and 2010. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

Figure D.4: Occupation dependent skill accumulation function

(a) Changes in wage premia

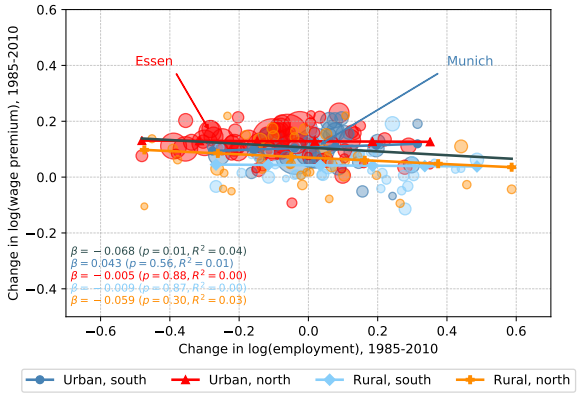
(b) Changes in worker quality



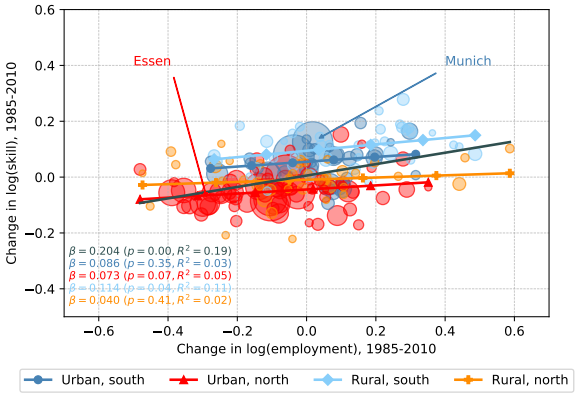
Notes: Figure D.4a shows estimated changes in wage premia between 1985 and 2010. OLS estimates as described by Equation (9) but omitting controls for changing amenities. Additionally, speed of skill accumulation depends on four occupation groups. Mgr-Prof-Tech: managers, professionals, technicians; Prod-Op-Crafts: production, operators, craftsmen; Srvc-Care: services and care. Classification of detailed occupations follows Acemoglu and Autor (2011), see Böhm et al. (2019) for the exact mapping. Figure D.4b shows estimated changes in worker quality as described by Equation (11) again omitting controls for changing amenities. The horizontal axes depict the change in log employment between 1985 and 2010. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

Figure D.5: Fixed effects estimation

(a) Changes in wage premia



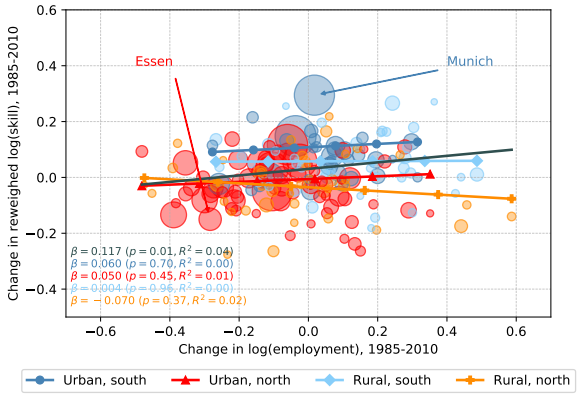
(b) Changes in worker quality



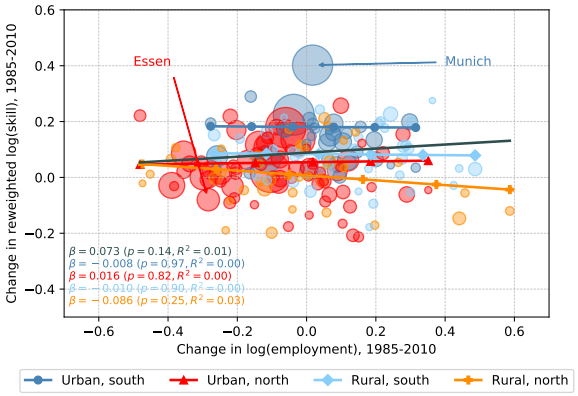
Notes: Figure D.5a shows estimated changes in wage premia between 1985 and 2010. Results were obtained from a fixed effects estimation including a separate worker-region fixed effect each time a worker revisits a local labor market similar to Cortes (2016). Wage premia are identified from year-region fixed effects. Region times detailed age dummies control for life cycle skill accumulation. Figure D.5b shows estimated changes in worker quality as described by Equation (11) using wage premia estimated as in Figure D.5a. The horizontal axes depict the change in log employment between 1985 and 2010. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

Figure D.6: Reweighted skill changes, education and industry

(a) Match 1985's education structure

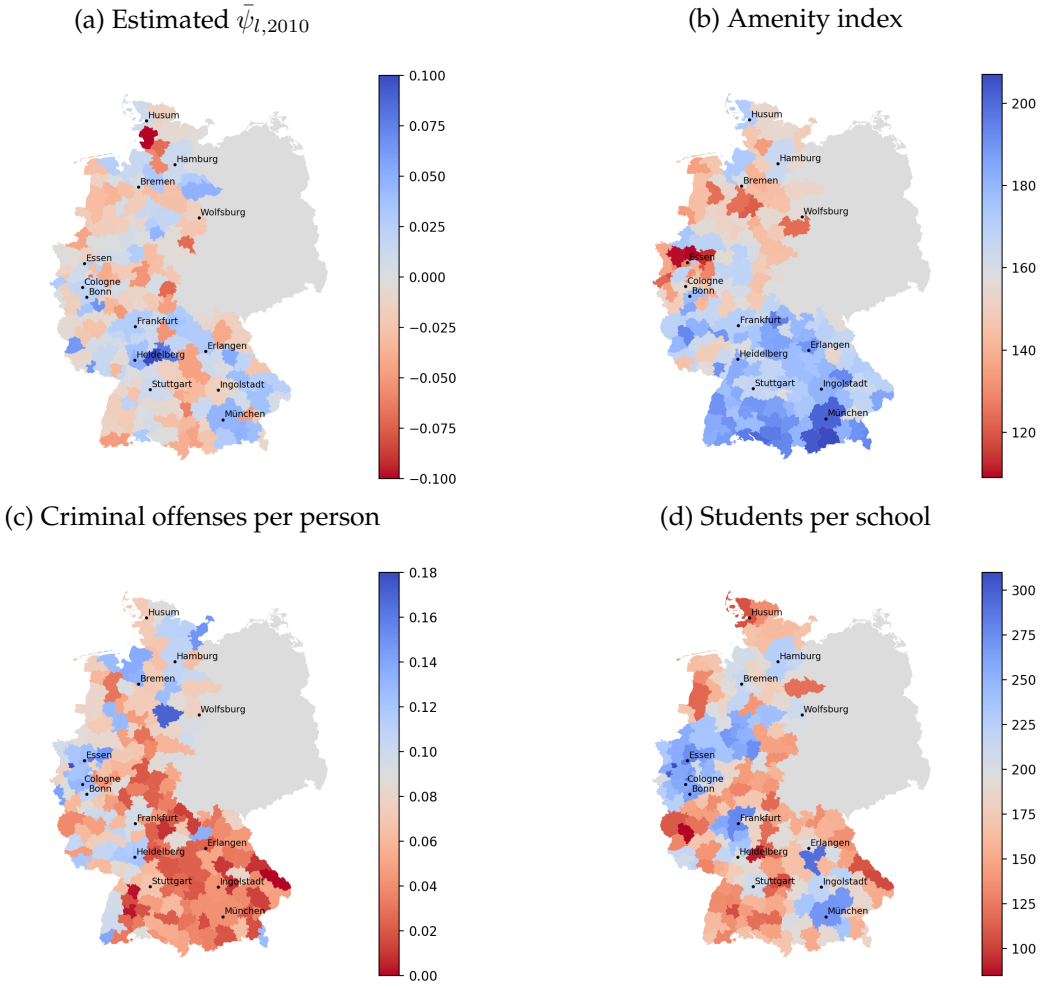


(b) Match 1985's industry structure



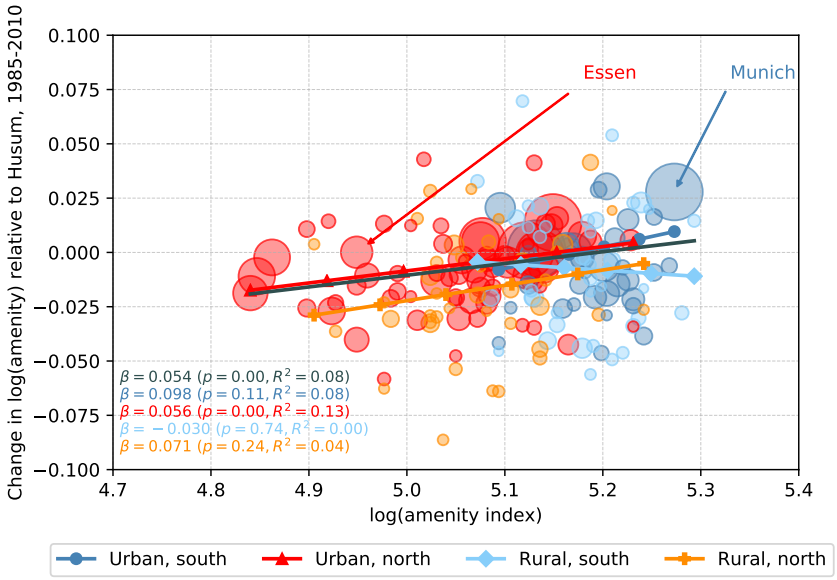
Notes: Figure D.6a shows estimated changes in worker quality as described by Equation (11). Observations were reweighted following DiNardo et al. (1996) to eliminate differential changes in the education structure across local labor markets. Figure D.6b repeats this by reweighting observations to eliminate differential changes in the industry structure across local labor markets. The horizontal axes depict the change in log employment between 1985 and 2010. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

Figure D.7: Amenities across space



Notes: The maps show the distribution of estimated amenities $\bar{\psi}_{l,2010}$ according to Equation (9) as well as collected amenity proxies across space. The amenity index was computed by prognos (2018) combining information on 53 amenity values ranging from sunshine duration to restaurant and physician density. Data on criminal offenses comes from Bundeskriminalamt (2018). The measure was computed as offenses divided by population collected from Statistische Ämter des Bundes und der Länder (2017a). Information on students per school was retrieved from Statistische Ämter des Bundes und der Länder (2017b). Assignment of political districts to West German local labor markets is based on commuting flows and follows Kropp and Schwengler (2011). East Germany is left out of the analysis.

Figure D.8: Estimated amenities $\bar{\psi}_{l,2010}$ and the external amenity index

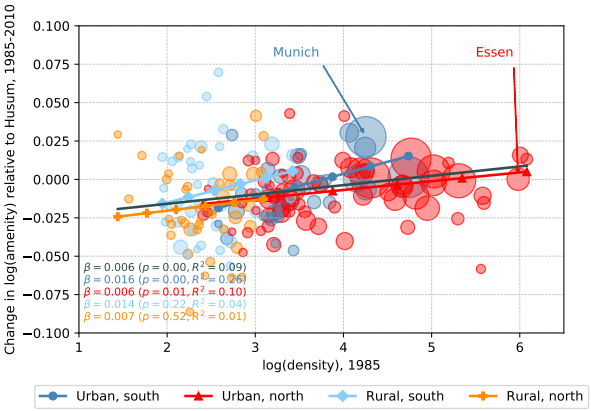


Notes: The vertical axis shows estimated amenity values $\bar{\psi}_{l,2010}$ according to Equation (9). The horizontal axis shows an amenity index computed by prognos (2018) combining information on 53 amenity values ranging from sunshine duration to restaurant and physician density. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

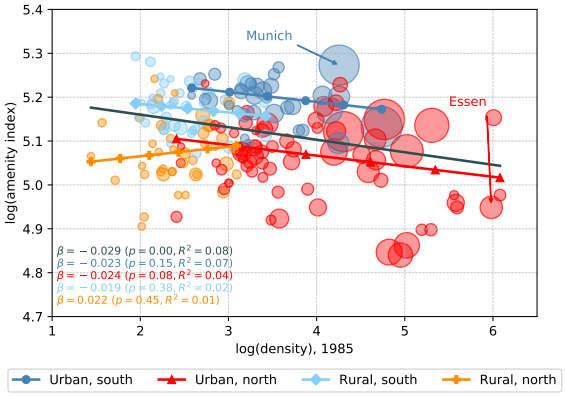
E Additional Results for Section 6

Figure E.1: Relation between amenities and density

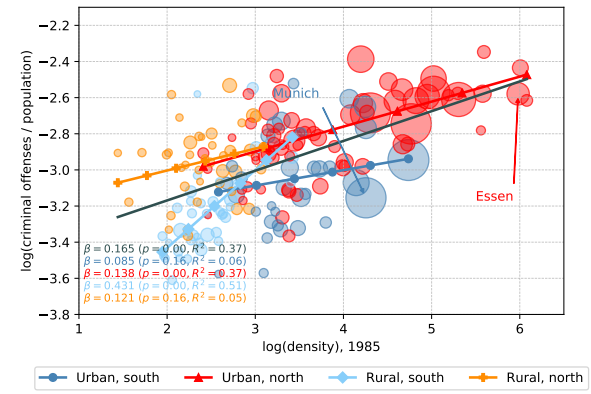
(a) Estimated $\bar{\psi}_{l,2010}$



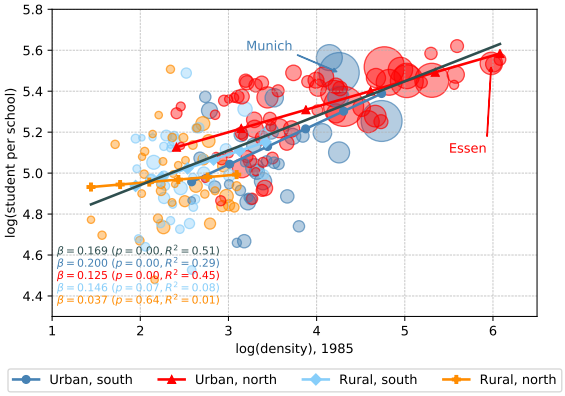
(b) Amenity index



(c) Crime per person



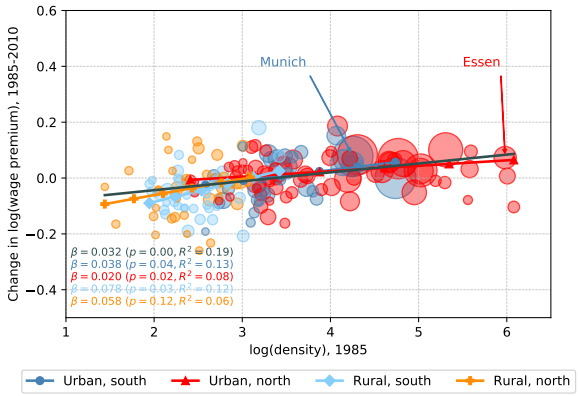
(d) Students per school



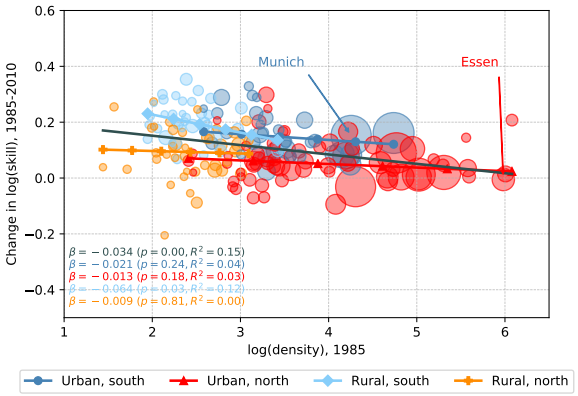
Notes: The vertical axes show estimated amenities $\bar{\psi}_{l,2010}$ according to Equation (9) (Figure E.1a) as well as collected amenity proxies. The horizontal axes depicts log employment density 1985 defined as number of employed workers in a market divided by area in square kilometers. The amenity index was computed by prognos (2018) combining information on 53 amenity values ranging from sunshine duration to restaurant and physician density. Data on criminal offenses comes from Bundeskriminalamt (2018). The measure was computed as offenses divided by population collected from Statistische Ämter des Bundes und der Länder (2017a). Information on students per school was retrieved from Statistische Ämter des Bundes und der Länder (2017b). One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.

Figure E.2: Wage premia vs density, omitting amenities, fixed effects

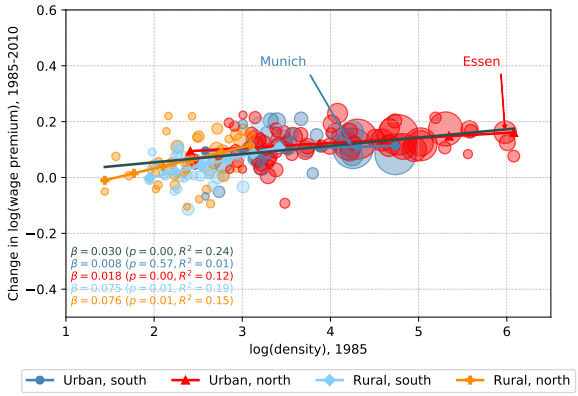
(a) Changes in wage premia, no amenities



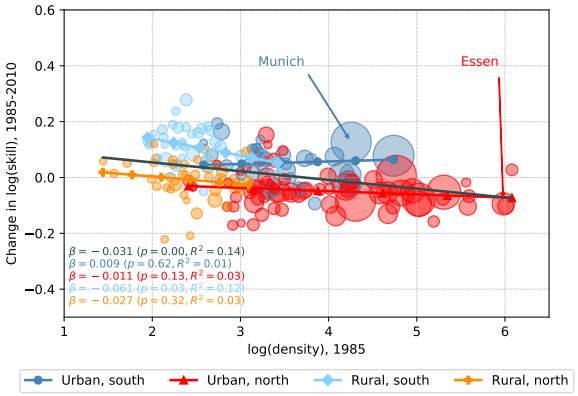
(b) Changes in worker quality, no amenities



(c) Changes in wage premia, fixed effects



(d) Changes in worker quality, fixed effects



Notes: Figure E.2a shows estimated changes in wage premia between 1985 and 2010. OLS estimates as described by Equation (9) but omitting controls for changing amenities. Figure E.2b shows estimated changes in worker quality as described by Equation (11) again omitting controls for changing amenities. Figure E.2c shows estimated changes in wage premia by means of a fixed effects estimation including a separate worker-region fixed effect each time a worker revisits a local labor market similar to Cortes (2016). Wage premia are identified from year-region fixed effects. Region times detailed age dummies control for life cycle skill accumulation. Figure E.2d shows estimated changes in worker quality as described by Equation (11) using wage premia estimated as in Figure E.2c. The horizontal axes depicts log employment density 1985 defined as number of employed workers in a market divided by area in square kilometers. One bubble represents one of 182 West German local labor markets aggregated from political districts as suggested by Kropp and Schwengler (2011). Bubble size corresponds to the number of employed workers in a market averaged across years 1985 to 2010. The four groups show a classification of local labor markets into northern and southern, rural and urban areas (see Appendix Figure A.1). Southern areas are located in Baden-Wuerttemberg and Bavaria. The classification of local labor markets into rural and urban is based on BBSR (2014). Regression lines are weighted by the number of employed workers.