Institute for Employment Research

The Research Institute of the Federal Employment Agency

IAB-Discussion Paper 33/2015

Articles on labour market issues

Commuting farther and earning more?

How employment density moderates workers' commuting distance

Malte Reichelt
Anette Haas

ISSN 2195-2663

Commuting farther and earning more?

How employment density moderates workers’ commuting distance

Malte Reichelt (IAB)
Anette Haas (IAB)

Contents

Abstract 4
Zusammenfassung 4
1 Introduction 5
2 Theoretical background 6
2.1 Explanations for commuting patterns 6
2.2 Commuting as a result of two distinct processes 8
3 Analytical strategy 9
3.1 Sample Selection 9
3.2 Statistical Method 10
3.3 Dataset 12
3.4 Operationalization 12
3.5 Population under analysis 13
4 Empirical Results 14
4.1 Descriptive evidence 14
4.2 Multivariate evidence 16
4.3 Robustness Checks 20
5 Conclusion 23
References 24
Appendix 28

Abstract

Over the past several decades, most industrialized countries have experienced a rise in commuting distances, spurring scholarly interest in its determinants. The primary theoretical explanation for longer commuting distances is based on higher wages; however, empirical evidence is minimal. We argue that commuting indeed often results from changes to jobs with higher wages. However, local labor market opportunities strongly moderate individuals' responsiveness to wage changes, resulting in diverse wage effects determined by the place of residence. Using German survey data linked to administrative information with a mixed-effects design, we find that when changing jobs the effect of wages on commuting distances rises substantially according to the local labor market density. While residents in the least dense areas do not adjust their commuting distance substantially in response to a wage change, residents in areas with the highest employment density are highly responsive. This result indicates the need to take into account the regional labor market structure when analyzing commuting patterns as local opportunities strongly influence the adjustment process of commuting distances. Particularly commuters from economic centers seem to adjust their distances to a great degree.

Zusammenfassung

Innerhalb der letzten Jahrzehnte hat ein Großteil der industrialisierten Länder einen Anstieg der Pendeldistanzen verzeichnet. Dies ruft zunehmendes Interesse an den Determinanten der Pendelstrecken hervor. Die primäre theoretische Erklärung für längere Pendeldistanzen basiert auf höheren Löhnen; die empirische Evidenz ist allerdings minimal. Wir argumentieren, dass Pendeln zwar oftmals aufgrund eines Wechsels zu einem Job mit höheren Löhnen entsteht, die regionalen Arbeitsmarktchancen dabei jedoch die individuelle Reaktion auf den Lohnanstieg moderieren. Dies führt zu unterschiedlichen Lohneffekten, je nach Wohnort der Arbeitnehmer. Wir nutzen Survey Daten aus Deutschland, die mit administrativen Informationen verlinkt sind. Mithilfe eines Mixed-Effects Designs zeigen wir, dass der Effekt von Löhnen auf die Pendeldistanz substantiell mit der Arbeitsmarktdichte steigt. Während Arbeitnehmer in Regionen mit der geringsten Dichte ihre Pendeldistanzen für eine Lohnveränderung kaum anpassen, reagieren Arbeitnehmer in den dichtesten Gebieten sehr stark. Das Ergebnis zeigt die Notwendigkeit, die regionale Arbeitsmarktstruktur bei Analysen von Pendelbewegungen zu berücksichtigen, da lokale Opportunitäten den Anpassungsprozess der Distanzen stark beeinflusst. Besonders Pendler aus wirtschaftlichen Zentren scheinen gewillt, ihre Distanzen stark anzupassen.

JEL classification: J61, J62, R12, R23

Keywords: Commuting distances, wage effects, labor market density, mixed-effects models

1 Introduction

Over the past decades, the average commuting distances between where people live versus where they work have risen steadily within many European and North American regions (Aguiléra 2005; Banister/Watson/Wood 1997; Cervero/Wu 1998; Frost/Linneker/Spence 1998; Haas 2000; Haas/Hamann 2008; Rouwendal/ Rietveld 1994). From a labor market perspective, the increase in mobility is desirable because commuting resolves problems of mismatch and helps to prevent unemployment (Clark/Huang/Withers 2003; Kalleberg 2008; Östh/Lindgren 2012). However, the negative repercussions of commuting are manifold and include environmental and infrastructural challenges (Brueckner 2000; Rouwendal/Rietveld 1994), weakening social ties (Viry/Kaufmann/Widmer 2009), challenges to personal relationships (Bunker et al. 1992) and lower productivity or higher absenteeism (Van Ommeren/ Gutiérrez-i-Puigarnau 2011). The determinants of commuting times and distances have therefore gained increasing public and scholarly interest in an attempt to understand the reasons for commuting.

The primary explanation for variation in commuting distances depends on wages, which are thought to compensate workers for the costs of traveling longer distances (Van Ommeren/Fosgerau 2009). Moreover, employees with higher wages relocate farther from their workplaces if they have particular or higher housing demands, which typically can be met in less dense areas (Alonso 1964; Muth 1969). Empirically, however, most studies only find small positive wage effects on commuting distances (Abraham/Nisic 2007; Groot/De Groot/Veneri 2012; Manning 2003). Other studies find zero or even negative effects of wages on commuting distances, indicating that this relationship is unclear (Gutiérrez-i-Puigarnau/Mulalic/Van Ommeren 2014).

We argue that these contradictory findings result from the fact that prior studies have failed to appreciate the importance of one's place of residence, which should strongly moderate the effects of wages on commuting distances. At labor market entry or after relocation, employees may choose an optimal housing and employer location combination. Residing in less dense areas will then most likely result in longer commutes to jobs in more dense areas.

Due to incomplete but improving information in the labor market (Jovanovic 1979) as well as changing labor market conditions, we assume that matches and wages can be improved by changing one's job. As jobs that offer higher wages will be spatially concentrated in dense areas, employees residing between economic centers will have little change in commuting distance when taking a job in another economic center. In contrast, residents in urban centers will either find a job locally and not adjust their commuting distance or find a job in another economic center, leading to a long distance change. The result is that wage increases predominantly lead to increases in commuting distances for employees in economic centers, which, in the long run, lead high-earnings employees to commute longer distances when residing in dense areas. We thus assume a moderating effect of the place of residence and tie our research to other studies, emphasizing the importance of spatial dimensions in the labor market (Rouwendal 1999; Van Ommeren/Rietveld/Nijkamp 1999).

We use data from Germany, the largest European economy and most populous European country, and draw on retrospective survey data that are linked to administrative information (ALWA-ADIAB) to test for wage effects on commuting distances. We then analyze whether the effects vary with employment density. By applying a mixed-effects design that distinguishes between- and within-employee effects of wages, we are able to distinguish between the wage effects due to workplace adjustment and the general wage effects on commuting distances that we expect as a long-term outcome.

The paper is structured as follows. First, we elaborate the theoretical background from which we derive hypotheses on the wage effects on commuting distances and distance changes. Second, we describe our analytical strategy, including the modeling design and the statistical method. Subsequently, we describe the datasets and our operationalization. Finally, we provide an overview of the descriptive and multivariate results as well as robustness checks before drawing a conclusion and presenting an outlook for potential further research.

2 Theoretical background

2.1 Explanations for commuting patterns

In Germany, the importance of commuting has risen steadily (Hofmeister/Schneider 2010; Kalter 1994). The percentage of employees with different counties of residence and work increased from 31 percent in 1995 to 39 percent in 2005 (Haas/Hamann 2008). Moreover, average commuting distances are increasing; they grew from an average of 14.6 km in 1999 to an average of 16.6 km in 2009 (BBSR 2012).

Theoretical approaches to explaining commuting uptake and commuting distances are manifold and focus on both incentives and restrictions to commutes. The basic urban economic theory argues that households choose their residential location to maximize their utility, balancing the increased costs of commuting against the advantages of cheaper unit prices of land (Alonso 1964; Muth 1969). In this framework, households and individuals must decide whether they prefer to profit from living in an agglomeration and thus face higher costs of living or whether they prefer to reside in a sparsely populated peripheral region with lower wages but also lower costs of living. In spatial equilibrium, all workers are thus fully compensated for longer commutes and travel costs by lower housing costs. The commuting distance is solely based on the household preference.[1]

Several extensions to the model imply the emergence of commuting due to a variety of reasons. Wasteful or excess commuting can originate due to search imperfections (Van Ommeren/Van der Straaten 2008) and implies that some workers commute between housing location A and work location B, whereas identical workers do the opposite (Hamilton/Röell 1982; Horner/Murray 2002; Manning 2003; Merriman/Ohkawara/Suzuki 1995; Small/Song 1992; White 1988). Local amenities may further prolong commuting distances (Ng 2008) and urban sprawl may lead to various directions of commutes (Travisi/Camagni/Nijkamp 2010). Accordingly, the urban structure and imbalances between employment and residential sites are thought to influence commuting patterns (Giuliano/Small 1993; Handy 1996). In this context, a strand of literature on spatial mismatch argues that lower employment rates and longer commutes for some ethnic groups in the US result from the lack of appropriate local vacancies (Gobillon/Selod/Zenou 2007; Holzer 1991; Kain 1992; Kain 1968; Preston/McLafferty 1999; Taylor/Ong 1995).

Approaches that focus on individual decision making mostly imply that employees with higher wages commute longer distances. Greater housing demand for high-income households can lead to a sorting of employees with high wages into longer commuting distances (Brueckner 2000). Accordingly, the primary economic explanation for commuting patterns lies in wage compensation for pecuniary and timely costs. As Manning (2003) argues, monopsony and thin labor markets lead to a positive correlation between wages and commuting distance. Although workers try to maximize wages and minimize commutes, job offers come at an infrequent rate, resulting in longer commuting distances for jobs with higher wages. Thus, job search may lead to changes in commuting distances when changing jobs.

Empirically, however, most studies find only small positive wage effects (Abraham/Nisic 2007; Groot/De Groot/Veneri 2012; Manning 2003). A recent study by Gutiérrez-i-Puigarnau, Mulalic and Van Ommeren (2014) even finds negative effects of wages on commuting distances, indicating that the assumed relationship is not as clear as theoretically derived. We argue, however, that the average effect is comparably small because commuting results from two distinct processes, which lead to diverse wage effects across the population. We will show that including the spatial dimension of urban economic theory in the predictions derived from job-search models yields new insights into the process of commuting in the labor market.

[1] A detailed discussion about the spatial equilibrium concept in urban economics can be found in (Puga 2010; Glaeser/Gottlieb 2009). Current work extends the spatial equilibrium concept with equilibrium unemployment by considering search frictions. Beaudry/Green/Sand (2014) embed a search and bargaining model of the labor market into a spatial equilibrium setting to discuss the joint determinants of local wages, unemployment rates, housing prices and migration.

2.2 Commuting as a result of two distinct processes

We claim that commuting results from two distinct processes. Employees may first sort themselves into an optimal housing-work combination, when entering the labor market or relocating, as predicted from urban economic theory (Alonso 1964; Muth 1969) However, we assume mismatches due to imperfect information (Jovanovic 1979) and changes in the labor market, such as the rise in technology or specialization of tasks (Autor 2013; Autor/Levy/Murnane 2003; Handel 2003; Kalleberg 2008; Oesch 2013). Moreover, search frictions suggest that appropriate job offers have a low arrival rate, potentially resulting in mismatches in the labor market (Manning 2003). These mismatches can be eliminated when changing employers, leading to better matches and higher wages. Accordingly, Van Ommeren, Rietveld and Nijkamp (1997) state that workers may accept residence-job connections while keep searching for better jobs and residences.

Due to substantial relocation costs, it is far more likely that employees will keep their housing locations and adjust to the new labor market situation by commuting. Local specific capital (DaVanzo 1983) and rising costs in land rents and housing prices increase the costs of relocation vis-à-vis commuting, especially because landlords may negotiate new rents when apartments become vacant (Basu/Emerson 2000). Moreover, given a preference for specific types of locations, the choice of residence location may be optimal for a variety of respective workplace locations within acceptable commuting distances. The adjustment process will thus most likely lead to a change in the commuting patterns and higher wages.

Formally, the condition to switch the job is a higher net utility, comparing a new wage offer (w_2) to the corresponding commuting costs (cc) and the current wage (w_1):

$$U[w_2(e_2) - cc(d_2); h_0] > U[w_1(e_1) - cc(d_1); h_0],$$

where cc is the commuting cost as a function of distance (d) between housing place 0 and workplace 1 or 2, and h_0 is the housing chosen at place 0 with the corresponding unchanged bundle of amenities. To accept a longer commute, d_2 must be greater than d_1. If d_2 is smaller than d_1, a shorter commute would be chosen, and if d_2 equals d_1, the same commuting distance would be chosen. The wage in this case is a function of the employment density e because the density affects the probability of vacancies with a good match and thus a high wage.

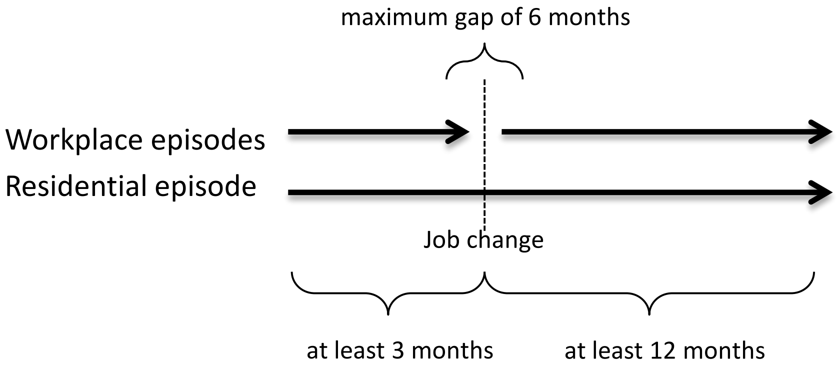
Because we first assumed sorting into different housing locations, the adjustment will not necessarily result in increased commuting distances for all commuters. Given mono- or polycentric labor markets, employees who reside in areas with a lower employment density should also have a lower probability of finding a high-wage job nearby. Even if jobs are accepted in a different economic center, new commuting distances will only vary to a low degree. In contrast, residents in dense economic centers will adjust their commutes more substantially. Given the spatial concentration of jobs, these residents should have a higher probability of either changing jobs locally or starting to commute to another economic center, thus considerably increasing the commuting distance. We thus expect wage effects on commuting distances to vary considerably. The adjustment process should predominately lead to positive wage effects for residents in economic centers with a high employment density. In the long run, high-earnings employees should have longer commutes predominantly in urban centers.

3 Analytical strategy

3.1 Sample Selection

To identify the effects of wages on commuting distances, we concentrate on changes in working episodes, while keeping the residential location fixed. As shown in Figure 1, we allow for a maximum gap of six months between the two workplace episodes and force the residential episode to be constant for at least three months before the end of the first episode and 12 months after the episode.

Figure 1
Sample selection



Source: Own illustration.

Restricting the sample to such job changes, we can first observe whether employees with longer commutes indeed have higher wages on average and, second, analyze whether employees accept longer commuting distances when changing to jobs that provide higher wages. Keeping the residence location constant, we should obtain labor-market-driven changes in commuting instead of changes that result from responses to the housing market or other reasons. Although changes that are driven by housing demand are relevant to commuting in general, they should not be directly linked to wages and are thus not of interest here. Moreover, changing jobs is far more frequent than changing the place of residence (Reichelt/Abraham 2015).

A major advantage of exploiting the longitudinal structure is that we are able to take into account changes in individual factors during the life course. These may encompass events such as the birth of children or changes in family status, which may have an impact on the accepted commuting distance. Furthermore, we can address the problem of endogeneity in the relationship between wages and commuting distance. Attempting to identify the causal effect of wages on commuting distance is not straightforward due to complex interactions (Haas/Osland 2014). Unobserved variables may cause spurious correlations. Higher productivity, for example, may positively influence both wages and travel distances. By keeping the place of residence constant, however, we can measure the effect of a change in wages on the change in commuting distances. This process cancels out the simultaneous effects of unobserved variables on both wages and commutes.

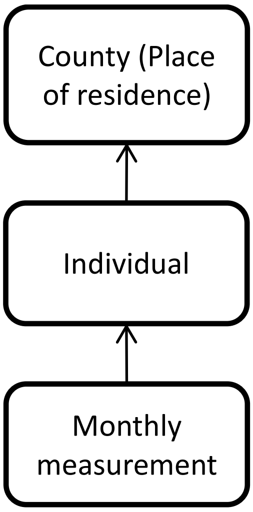
Further endogeneity may arise from potential reverse causation (Gutiérrez-i-Puigarnau/Mulalic/Van Ommeren 2014; Mulalic/Van Ommeren/Pilegaard 2014). Employers may reimburse employees for commuting longer distances, thus leading to a reverse causal effect of commuting distance on wages. There have been several approaches to address this problem, which mostly draw on instrumental variable estimation. However, it is problematic to find adequate instrumental variables that influence wages but do not affect the workplace location (Manning 2003). We argue that in the case of an employer change, the potential wage will be known beforehand, and reverse causation is not given in such a setting. Moreover, in Germany, it is uncommon for employers to reimburse employees who reside farther away because for the majority of employers, the wage-setting mechanism draws on wage posting instead of bargaining (Brenzel/Gartner/Schnabel 2014; Wallerstein/Golden/Lange 1997). Accordingly, Manning (2003) argues that in a competitive market, employers should pay the same wages to identical workers and that a pay raise is unlikely to be granted because of a longer commuting distance. As a robustness check, however, we discard employees who are assumed to have the highest bargaining power and thus exclude cases in which increases in commuting distances could be ascribed to commuter reimbursement.

3.2 Statistical Method

The aim of this paper is to identify the effect of wage changes on commuting distances and to analyze how this effect varies with the local employment density. Moreover, we aim to test whether the same effects generally hold for the wage level. To address these questions, we calculate the effect of the logarithm of wage on the logarithm of commuting distance using hybrid mixed-effect panel regressions.

Selecting the most recent job change in an individual's career, we obtain a longitudinal data structure with constant places of residence. In this structure, panel measurements are nested within individuals, which are nested within regions, as shown in the classification diagram in Figure 2.

Figure 2
Classification diagram



Source: Own illustration.

In such a setting, measurement occasions may not be independent from unobserved individual and regional factors. Mixed-effects (also commonly termed multilevel or hierarchical) panel regressions, however, account for unobserved regional influences and the interdependency of measurements. A major advantage of this method is the ability to calculate a hybrid model and thus to estimate fixed and random effects, which are both of interest because they analytically separate the general or long-term effects on commuting patterns and changes due to labor market adjustment. Using group-mean centering, we obtain fixed effects for time-varying covariates and may further include time-invariant factors as well as an estimate of the unobserved variation between individuals and regions.

The model can be written as follows:

$$y_{irt} = \beta_0 + \beta_1(w_{irt} - \overline{w}_{ir}) + \beta_2\overline{w}_{ir} + \beta_3 x_{irt} + \nu_r + u_{ir} + \epsilon_{irt}$$

with

$$\nu_r \sim N(0, \sigma_\nu^2), u_{ir} \sim N(0, \sigma_u^2),\ \epsilon_{irt} \sim N(0, \sigma_\epsilon^2),$$

where y_{irt} is a commuting measurement for month t for a given individual i in a given region r. The random part consists of normally distributed random intercepts ν_r for regions and u_{ir} for individuals within regions and the individual residual ϵ_{irt} at measurement point t, conditioned on the individual and the region random effect. Separating the wage effect using Mundlak's formulation (Bell/Jones 2015; Mundlak 1978), we obtain a hybrid model and thus separate measures for the within-person effect of wage (or the effect of wage changes $w_{irt} - \overline{w}_{ir}$) on commuting distance β_1 and a between-person effect of wage (or the effect of wage level $\overline{w}_{ir}$) on commuting distance β_2. The former represents the same effect we would obtain in a fixed-effects model, whereas the latter represents the general or long-term effect of wages on the commuting distance. For all models, we use restricted maximum likelihood estimation.

3.3 Dataset

For our analyses, we draw on retrospective data from the survey "Working and Learning in a Changing World" (ALWA) (Antoni et al. 2010), which is linked to administrative data (ALWA-ADIAB)[2]. The dataset combines the retrospective survey and administrative data on the person and firm level (Antoni/Jacobebbinghaus/Seth 2011; Antoni/Seth 2012). The survey was conducted in 2007/2008 and includes 10,177 computer-assisted telephone interviews (CATI) that encompass monthly residential, workplace, educational, employment and partnership histories in Germany (Kleinert et al. 2011). The sample is representative of Germany and covers people born between 1956 and 1988. The linked survey provides access to information of the Federal Employment Agency (BA), which allows us to consider accurate wage data for all employees in the data who are subject to social security contributions.

We additionally link distance measures between municipality centroids provided by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR). The measure is used to define commuters and commuting distance. Moreover, we include regional unemployment rates, the development in employment and employment density on the county level. The latter is used to differentiate wage effects depending on the housing location, whereas unemployment rates and employment development are used to control for regional influences on wage effects.

3.4 Operationalization

Three constructs are at the heart of this analysis: individuals' *wages, commuting distances* and *employment density* within the county. The former is measured as the natural logarithm of the daily wage, retrieved through the administrative data of the BA for all employees who are subject to social insurance contributions. The wage data are linked to the ALWA survey on a monthly basis, achieving a high level of validity. We employ a method proposed by Reichelt (2015) to impute right-censored wages above the contribution limit, deflate wages and match the data to the survey structure. The distance is measured as the natural logarithm of the linear distance between municipality centers of place of residence and place of work and is obtained through the BBSR. Due to several changes in spatial classifications, we recode all municipality identifiers to the most current state and retrieve a common classification that allows us to match the commuting distance and calculate the employment density as the ratio of all employees subject to social security contributions

[2] Access to the dataset is provided via the Research Data Center (FDZ) of German Federal Employment Agency at the IAB and is given through on-site-use and subsequent remote data access. See http://fdz.iab.de/en.aspx for more information.

in a given county to the county's spatial area in hectare. We center the variable to obtain meaningful results for interaction effects.

Our structural control variables encompass the county's unemployment rate and the employment growth rate. We use additional control variables for other determinants of commuting distance, which are predominantly borrowed from migration research. *Formal education* is classified as the highest educational degree obtained during regular schooling and is controlled for by four dummy variables, including (1) no degree (2) lower secondary [Hauptschule] (3) medium secondary [Mittlere Reife] and (4) upper secondary education [(Fach-)Abitur], which represents the entrance qualifications for university and tertiary institutions. Because educational degrees may be obtained after regular schooling, we include a dummy variable indicating whether a higher educational degree is obtained through *second chance schooling*. *Vocational* and *academic training* is controlled for by dummies representing no formal training, vocational or academic training, leaving vocational training as the reference category. Because residential mobility costs can be affected by the *composition of the household*, we include dummy variables for family status, measured as living in a household without a partner, with an unmarried partner or with a married partner. Children in the household are differentiated between age groups and encompass years 0-3, 3-6, 6-18 and 18+. We also include a variable for the *duration of residence* in years to manage local ties for employees without former relocation experience. To control for *industrial sector*-specific effects, an aggregation of the NACE classification is included with seven categories. Moreover, a dummy indicating an employment relation within the *public sector* (vs. the private sector) is included. Other controls cover *year* and *month dummies*, *age*, *sex* and *nationality*. A complete list of control variables and descriptive statistics can be found in the appendix.

3.5 Population under analysis

We restrict the sample population according to several characteristics. The BA only collects wage information for employees subject to social security contributions. Therefore, we exclude the self-employed and the marginally employed. Furthermore, we exclude all part-time employees because we do not have administrative information on the hours worked. We use information on all primary employment relations, and a dummy variable is included for all secondary or overlapping primary employment relations.

We draw on monthly information – both from retrospective survey data and administrative data – between January 1993 and the interview date in 2007/2008 because wage measurements for East Germany before reunification are missing. Moreover, observations before receiving the highest regular schooling degree are excluded because we want to select regular employment relations. We exclude observations of employees with parallel places of residence because we are not able to identify the commuting pathways for this population. Furthermore, observations with commuting distances of more than 200 km are excluded because we assume that there may be other means (i. e., airplanes) or other types (weekend commuters) of commuting that impose different cost structures. Although we have no information on the frequency of commutes, we can thus minimize potential bias due to deviant commuting patterns.

Because we use the logarithm of distance and wage, all observations that have a commuting distance of 0 km are set to missing. Thus, all observations in which an individual resides in the same municipality where (s)he works are excluded, a standard procedure in commuting analyses. According to our analytical design, we only keep information on those employees who have a constant place of residence and change employers. For all employees who exhibit more than one job change with a constant residence location, we select the most recent combination. Moreover, we exclude observations that correspond to a wage increase of more than 100 percent or a decrease of more than 50 percent because we assume imprecise wage information due to partial imputation.

4 Empirical Results

4.1 Descriptive evidence

The aim of this article is to evaluate whether the adjustment process leads to a positive effect of wages on commuting distance mostly for residents in areas with high employment density. After restricting our sample as described above and excluding observations with missing information on either of the control variables, we observe positive commuting distances for 1,023 employees, tantamount to different work and residence locations for at least one of the two selected employment episodes. These episodes correspond to 99,667 monthly observations. We use this restricted sample for all further descriptions and multivariate analyses because we use the logarithm of the distance in our regressions, which excludes distances of 0 km.

Table 1 shows average wages and distances as well as the average changes in wages and distances. We use mean wages for the employment episodes to indicate the amount of the change in wages. On average, we observe daily wages of approximately 91.8 Euros, which corresponds to a monthly gross wage of approximately 2,793 Euros. According to official statistics, this value is slightly higher compared to the population average. However, considering that we exclude non-commuters and assume a positive relationship between commuting distance and wages, this finding is not surprising. The average commuting distance is approximately 20.1 km, which shows that the majority of commutes are of a short-distance nature. The average change in daily wages is positive, with a 8.5 Euro increase, whereas the average change in distance is an increase of 200 meters.

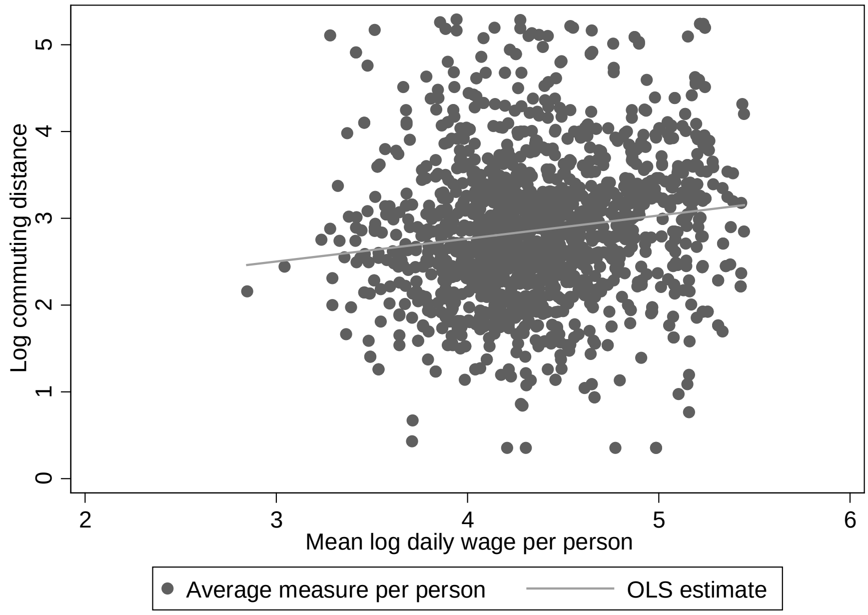
Table 1
Descriptive results for average wages and distances

	Mean	Std. Dev	Min	Max
Daily wage in EUR	91.82	44.20	10.14	427.26
Wage change in EUR	8.48	19.37	-107.45	91.43
Distance in km	20.08	26.28	0	198.82
Distance change in km	0.20	32.47	-181.73	193.20

Source: ALWA-ADIAB, own calculations, restricted sample, n=1,023; years 1993-2008

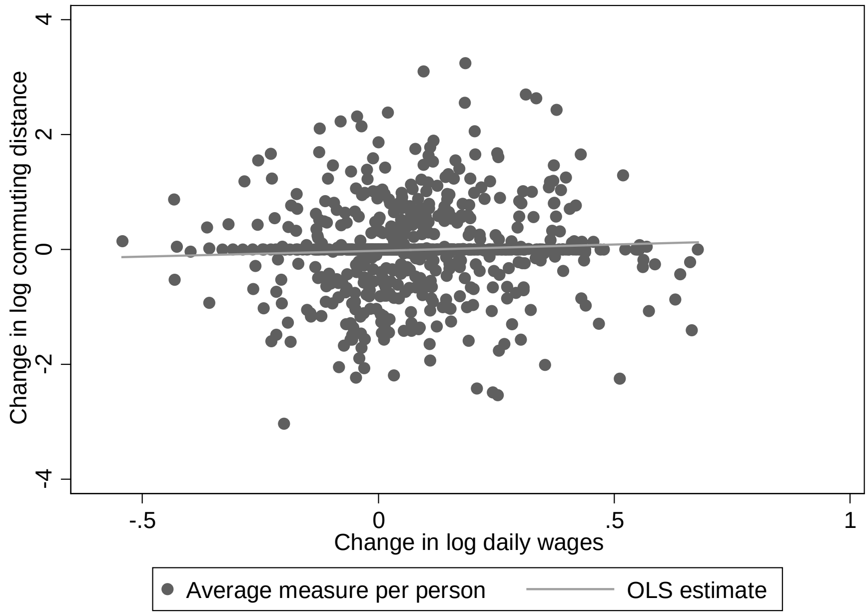
To provide an impression of the relationship between wages and distances, Figure 3 and 4 show scatterplots of the log mean wages and distances (n=1,723) as well as the average changes in log wages and distances (n=703). The graphs show that the two measures in general are positively correlated (ρ=0.13), but the relationship between wage and distance changes is fairly small (ρ=0.05). This result corresponds to our expectation that a positive sorting effect will result in higher wages for employees who commute longer distances and that the adjustment effect might result in a relative wage increase only for some employees.

Figure 3
Scatterplot: Mean wages per person and commuting distances



Source: ALWA-ADIAB, own calculations, restricted sample, n=1,723; years 1993-2008

Figure 4
Scatterplot: Average change in wages and commuting distances



Source: ALWA-ADIAB, own calculations, restricted sample, n=703; years 1993-2008

4.2 Multivariate evidence

The descriptive results mainly support our assumptions on rising commuting distances with higher wages due to sorting and long-run effects and small composite effect of wage changes on distance changes. For a more detailed analysis and to test the assumption that the latter effect varies with employment density, we employ a multivariate analysis. We use mixed-effect panel regressions to analyze the effect of the logarithm of wage on the logarithm of commuting distance as well as regional differences in these effects.

Table 2 shows a null model, a model with wage measures, a model with control variables, an interaction effects model and a model with structural control variables. For readability, we only depict a selection of all variables. Full models with all control variables can be found in the appendix. We keep the sample identical for all models and obtain 83,697 observations for 1,023 individuals in 250 counties.

Table 2
Mixed effects models

Explanatory Variables	Dependent Variable: ln commuting distance				
	Model 1: Null Model	Model 2: Base model with wage effects	Model 3: Controls model (wage main effects)	Model 4: Controls model (wage interaction effects)	Model 5: Structural controls
Employment density	-0.013*	-0.019**	-0.022**	-0.017*	-0.023**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
$\ln(\bar{w})$		0.207***	0.089	0.186*	0.181*
		(0.056)	(0.071)	(0.074)	(0.075)
$\ln(\bar{w})$ * Employment density				0.074***	0.075***
				(0.014)	(0.014)
$\ln(\Delta w)$		0.075***	0.070***	0.122***	0.123***
		(0.009)	(0.009)	(0.009)	(0.009)
$\ln(\Delta w)$ * Employment density				0.037***	0.037***
				(0.003)	(0.003)
Unemployment rate					-0.004***
					(0.001)
Change in number of employees					-0.580***
					(0.148)
Unemployment rate * Change in number of employees					0.048***
					(0.011)
Constant	2.822***	2.937***	2.108***	2.119***	2.159***
	(0.035)	(0.040)	(0.374)	(0.376)	(0.376)
Individual controls			✓	✓	✓
v_r County constant	0.358***	0.459***	0.441***	0.435***	0.450***
u_{ir} Person constant	0.707***	0.686***	0.700***	0.704***	0.704***
N Counties (level 3)			250		
N Persons (level 2)			1,023		
N Observations (level1)			83,697		

Note on significance levels: ***p≤0.001 **p≤0.01 *p≤0.05; Standard errors in parentheses
Complete regression table in the appendix

Source: ALWA-ADIAB, own calculations, restricted sample, n=1,023; years 1993-2008

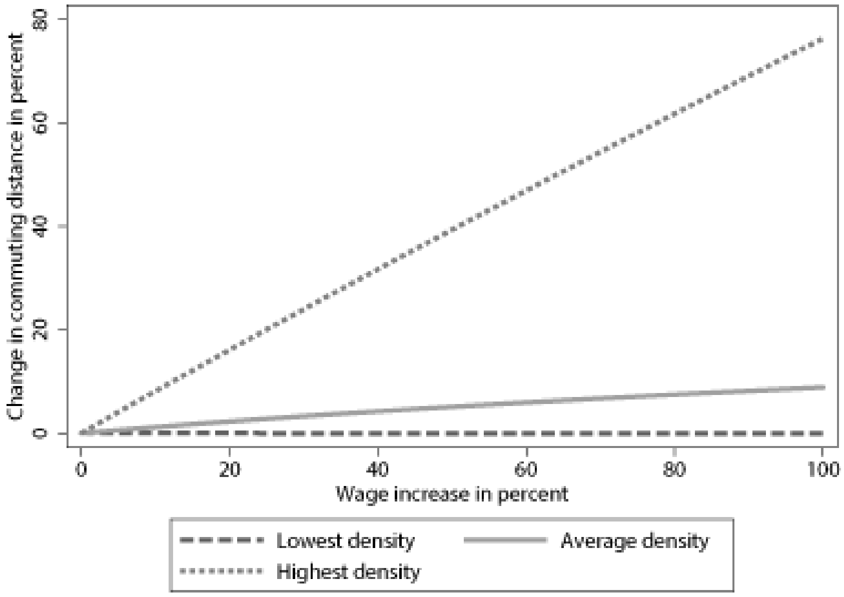
The null model, which only includes employment density, month and year dummies, and a dummy for East Germany, shows the relative effect of employment density on commuting distance. As expected, the commuting distance is lower for employees who reside in dense labor markets. Comparing the predicted commuting distances between the areas with the lowest and the highest density, we obtain a difference in distances of 28.8 percent [(1-EXP^(-0.013))*22.26]. The variances at both the person and the county level are significant, which shows that there is unobserved heterogeneity on both levels explaining commuting distances.

Model 2 adds the logarithm of the group mean-centered wage and the logarithm of the change in wages. As expected, both effects are positive, showing that employees with higher wages commute longer distances and that employees generally increase their distance for wage increases. This finding supports the assumptions that sorting leads to longer commuting distances for employees with higher wages and that incomplete information or structural factors promote a change in jobs to improve matching and realize higher wages. However, complementing the descriptive evidence and in line with results from other studies, the latter effect is rather small. A 50 percent increase in wages results in a 3 percent longer commute [1.5^(0.075)]. Although employees with 50 percent higher earnings generally commute 9 percent longer distances, the effect does not explain the positive relationship between density and commuting distances. Employees with higher earnings seem to generally commute longer distances. This result may either reflect that our sample comprises employees who had already changed their workplaces or that housing within cities has become more expensive and that employees with high earning tend to move back into cities and reside close to city amenities.

Model 3, which adds control variables, shows that the positive effect of mean wages on commuting distances vanishes. Thus, employees with certain characteristics (i. e., with an academic degree) tend to earn more and commute longer distances. However, the positive effect of a wage increase remains stable. We assume that this composite effect is small because employees would first sort themselves into a place of residence-place of work combination according to their preferences and housing demands and then adjust their commuting distance when changing jobs. Those residing in less dense areas will most likely only slightly adjust their commuting distances when changing jobs because job offers are likely to arrive from economic centers outside the local labor market. By contrast, employees residing in dense areas either increase their commuting distance substantially because they are geographically farther away from other economic centers or remain in their local labor market. In this sense, they react more sensitively to incoming job offers.

Model 4 includes the interaction between employment density and the wage measures. The main effects of the wage measures provide information on the effects in an area with average employment density, whereas the interaction terms provide information on the degree to which this effect varies with density. We observe a positive mean wage effect for employees residing in a region with an average employment density. The higher the density, the greater the effect, which shows that employees with high wages commute the longest distances when residing in dense areas. Again, this result indicates that the commuting distances between economic centers should be the longest. If employees have a preference for residing in a specific urban area or restrictions to relocate but take a job with higher earnings in another regional labor market, they commute farthest. Likewise, the effect of a wage change positively interacts with employment density. This finding is in line with our prediction that the sorting process leads to different adjustment processes in the labor market. Depending where an employee resides, (s)he will increase the commuting distance differently when finding a better match. The magnitude of these effects is shown in Figure 5, which plots the interaction effects and shows the average wage effect on the relative increase in commuting distance depending on employment density. As Figure 5 shows, doubling the wage for an employee residing in the county with the lowest density would only slightly increase in the commuting distance. In contrast, doubling the wage for an employee residing in the county with the highest density would lead to an increase of approximately 80 percent.

Figure 5
Average effect of a wage increase on the change in commuting distance



Source: ALWA-ADIAB, own calculations, restricted sample, n=1,023; years 1993-2008

In the last model, we include structural control variables to test whether the wage effects hold when local labor market conditions are taken into account. The change in the number of employees and the unemployment rate are indicators of the local opportunity structure. We interact the two measures to capture the emergence of job opportunities with high and low competition on the local labor market. A positive change in the number of employees is associated with short commutes when the unemployment rate is low. Thus, the emergence of jobs under low local competition allows employees to choose jobs that are closer to their place of residence. With a higher unemployment rate, the effect becomes positive indicating that employees choose workplaces that are farther away when local competition for new jobs is high. The unemployment rate has a significant negative effect when the change in employees is zero. High unemployment thus only seems to drive employees farther away when the overall development is positive. One explanation may rest in our analytical design because we are only taking into account episodes from job changes. If the unemployment rate is high and no new local jobs emerge, employees seem to remain in their jobs, become unemployed or relocate.

The wage effects do not seem to be affected by the local labor market condition, indicating that the adjustment due to arriving job offers does not strongly depend on the local labor market. On average, employees are willing to accept longer commuting distances for a wage increase, notwithstanding the local development.

For all models, we estimate significant variance in the person and county constants, which indicates that further explanations for the length of commuting distances can be found on both levels. Other individual and structural factors that we did not explicitly model here seem to influence the accepted travel distance to work. Nevertheless, we obtain some interesting results from our control variables, although the main interest in this study rests on the differential wage effects. Most of the factors are retrieved from migration research, whereas most commuting studies have thus far not been able to include such detailed individual information. Surprisingly, some determinants of migration do not hold for predicting commuting distance and vice versa, indicating that commuting and migration are not perfect substitutes and that the influences on both decisions underlie different mechanisms. Although age is a strong predictor of migration, commuting distances are not affected. Keeping in mind that migration costs are assessed considering potential lifetime income, relative costs rise with age. For commuting, this argument does not hold because costs and income surplus are weighted against each other directly. Having a partner in the household – either unmarried or married – results in longer commuting distances. The effect should be attributable to dual-earner households that face restrictions to finding appropriate matches at the same location. Furthermore, compared to employees with no children at home, commuting distances for employees with children under six years of age are shorter. The negative effect might be ascribed to the higher time demand of the household.

4.3 Robustness Checks

We conducted several robustness checks to ensure that the wage effects and their dependence on the local labor market density are not attributable to our study design or our sample selection. Table 3 shows the results of nine models that we conducted using different specifications. We use data from the beginning of our observational period to ensure that we are not capturing a periodic effect. For both analytical time frames, we also use county centroids instead of municipality centroids to calculate the commuting distance, thus excluding short-distance commuters within counties. For the same reason, we exclude commuting distances shorter than five kilometers. To ensure that we are not facing reverse causation and employers that reimburse commuters with higher earnings, we exclude potential bargainers – namely, employees with at least one subordinate worker who perform a highly complex job. We exclude cities of more than 500,000 inhabitants to ensure that commuting patterns from residents of the largest areas are not driving our results, and we exclude East Germany because commuting patterns are known to vary between the two regions in Germany. Lastly, we employ log hourly wages, calculated with contract hours from the survey, and we reduce the maximum gap between employment spells to three months.

The main effect of the wage level is always positive, but it lacks significance in some models. However, the interaction effect with employment density is always significant and positive, showing that the finding that employees with higher wages predominantly commute long distances when they reside in dense areas is robust. The effects of wage changes and their interaction with employment density are quite robust and stable. Thus, the findings that the adaption process predominantly leads to higher wages and increased commuting distances for residents in dense regions is robust and does not seem to be dependent on the sample choice or the analytical design.

Table 3
Robustness checks

	Municipality centroids - beginning of observational period	County centroids - end of observational period	County centroids - beginning of observational period	Bargainer exclusion	Exclusion of cities >500,000	Exclusion of commuting distances <5 km	West Germany	Log hourly wages	Maximum gap of 3 months between episodes
$\ln(\bar{w})$	0.056	0.249***	0.133	0.076	0.122	0.184**	0.228**	0.222**	0.126
	(0.076)	(0.075)	(0.078)	(0.082)	(0.093)	(0.069)	(0.081)	(0.070)	(0.077)
$\ln(\bar{w})$ * Employment density	0.052***	0.076***	0.056***	0.073***	0.097***	0.056***	0.070***	0.094***	0.079***
	(0.015)	(0.015)	(0.016)	(0.016)	(0.022)	(0.013)	(0.015)	(0.014)	(0.014)
$\ln(\Delta\, w)$	0.132***	0.079***	0.112***	0.110***	0.156***	0.094***	0.092***	0.112***	0.099***
	(0.010)	(0.009)	(0.010)	(0.009)	(0.011)	(0.008)	(0.009)	(0.008)	(0.009)
$\ln(\Delta\, w)$ * Employment density	0.030***	0.041***	0.040***	0.036***	0.049***	0.028***	0.029***	0.036***	0.034***
	(0.003)	(0.002)	(0.003)	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)
Employment density	-0.270***	-0.363***	-0.292***	-0.344***	-0.432***	-0.270***	-0.315***	-0.271***	-0.367***
	(0.070)	(0.068)	(0.075)	(0.070)	(0.099)	(0.060)	(0.067)	(0.039)	(0.066)
Observations	77,016	88,602	80,659	72,645	79,827	80,687	73,100	83,949	79,039

Note on significance levels: ***p≤0.001 **p≤0.01 *p≤0.05; Standard errors in parentheses

Source: ALWA-ADIAB, own calculations, years 1993-2008

5 Conclusion

Over the past several decades, commuting has become increasingly important as a means of labor market adjustment. Identifying the determinants of commuting distances is of interest to many social sciences but is by no means straightforward due to complex job and housing decisions. We argued that commuting results from a two-stage process in which sorting leads to a temporary optimal housing/work combination that is subsequently adjusted. Due to changes in occupational structure, improvements in technology or simply incomplete information, matches are supposedly non-optimal in many cases. These effects can be eliminated by changing the job. In this adaption process, the place of residence is of crucial importance. Facing mono- and polycentric labor markets, job opportunities will predominantly emerge in economic centers. Employees who reside between economic centers – and thus in less dense areas – can adjust their commutes without having to increase the distance. In contrast, employees who reside in dense areas react more sensitively with regard to the commuting distance. Either they commute long distances into other local labor markets, or they commute very short distances. We assumed these relationships to be responsible for the overall small wage effect.

To test our assumptions, we focused on commuters who change their jobs and keep their places of residence. Using a mixed-effects design and matched data from the German ALWA-ADIAB survey combined with precise wage information from administrative data, we were able to examine hypotheses concerning wage levels and wage increases. We find overall positive effects of wage changes on changes in the commuting distance. Indeed, as we assumed, these effects vary greatly by employment density. Employees residing in dense areas are mainly accountable for the positive effect. Thus, labor-market-driven adjustments of the working place result in longer commutes only for a subgroup. The positive wage effect on commuting distances, which is found in other studies, does not apply to all employees and heavily depends on the residential location. Moreover, we find support for the hypothesis that in the long run, the relationship leads to a phenomenon in which high-earnings employees predominantly commute longer distances when they reside in urban areas. Because macro indicators of the local labor market context do not affect the effects we found, we assume that on average, employees seem to be willing to accept longer commuting distances for a wage increase, notwithstanding local conditions.

The limitations of this study mainly result from our commuting measures because we were only able to measure the commuting distance with municipality centroids. Employees who commute within cities were thus counted as non-commuters and did not enter the analysis. Several robustness checks suggest that the mechanisms we found generally hold; however, further research that draws on geo-coded data and actual travel distances could examine whether within-city commuters follow a different logic. In general, it can be assumed that urban residents have greater dispersion in the change of commuting distances due to labor market adjustments. As we have argued, employees in dense areas will either accept a job nearby or will travel a far greater distance to establish better matches. The result is that the effects of earnings on commuting distances are largest in dense urban areas, indicating the need to focus on commuting behavior between economic centers and to take into account the local opportunity structure when analyzing commuting patterns.

References

Abraham, Martin; Nisic, Natascha (2007): Regional Ties, Geographical Mobility and the Labour Market. Analyses for Switzerland and Germany. In: Swiss Journal of Sociology, Jg. 33, No. 1, S. 69–88.

Aguiléra, Anne (2005): Growth in Commuting Distances in French Polycentric Metropolitan Areas: Paris, Lyon and Marseille. In: Urban Studies, Jg. 42, No. 9, S. 1537–1547.

Alonso, William (1964): Location and Land Use. Cambridge, USA: Harvard University Press.

Antoni, Manfred; Drasch, Katrin; Kleinert, Corinna; Matthes, Britta; Ruland, Michael; Trahms, Annette (2010): Arbeiten und Lernen im Wandel: Teil I: Überblick über die Studie - März 2011 (2. aktualisierte Fassung des Berichtes vom Mai 2010). FDZ-Methodenreport, 05/2010.

Antoni, Manfred; Jacobebbinghaus, Peter; Seth, Stefan (2011): ALWA-Befragungsdaten verknüpft mit administrativen Daten des IAB 1975-2009 (ALWA-ADIAB). FDZ-Datenreport, 05/2011.

Antoni, Manfred; Seth, Stefan (2012): ALWA-ADIAB – Linked Individual Survey and Administrative Data for Substantive and Methodological Research. In: Schmollers Jahrbuch, Jg. 132, No. 1, S. 141–146.

Autor, David H. (2013): The “task approach” to labor markets: an overview. In: Journal for Labour Market Research, Jg. 46, No. 3, S. 185–199.

Autor, David H.; Levy, Frank; Murnane, Richard J. (2003): The skill content of recent technological change: an empirical exploration. In: The Quarterly Journal of Economics, Jg. 118, No. 4, S. 1279–1333.

Banister, David; Watson, Sandra; Wood, C. (1997): Sustainable cities: transport, energy, and urban form. In: Environment and Planning B: Planning and Design, Jg. 24, No. 1, S. 125–143.

Basu, Kaushik; Emerson, Patrick M. (2000): The Economics of Tenancy Rent Control. In: The Economic Journal, Jg. 110, No. 466, S. 939–962.

BBSR (2012): Raumordnungsbericht 2011. In: Einig, Klaus (ed.): Raumordnungsbericht. Bonn. Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) im Bundesamt für Bauwesen und Raumordnung.

Beaudry, Paul; Green, David A.; Sand, Ben (2014): Spatial Equilibrium with Unemployment and Wage Bargaining: Theory and Estimation. In: Journal of Urban Economics, Jg. 79, S. 2–19.

Bell, Andrew; Jones, Kelvyn (2015): Explaining Fixed Effects: Random Effects Modeling of Time-Series Cross-Sectional and Panel Data. In: Political Science Research and Methods, Jg. 3, No.1, S. 133–153.

Brenzel, Hanna; Gartner, Hermann; Schnabel, Claus (2014): Wage bargaining or wage posting? Evidence from the employers' side. In: Labour Economics, Jg. 29, No.1, S. 41–48.

Brueckner, Jan K. (2000): Urban Sprawl: Diagnosis and Remedies. In: International Regional Science Review, Jg. 23, No. 3, S. 160–171.

Bunker, Barbara B.; Zubek, Josephine M.; Vanderslice, Virginia J.; Rice, Robert W. (1992): Quality of Life in Dual-Career Families: Commuting versus Single-Residence Couples. In: Journal of Marriage and Family, Jg. 54, No. 2, S. 399–407.

Cervero, Robert; Wu, Kang-Li (1998): Sub-centring and Commuting: Evidence from the San Francisco Bay Area, 1980-90. In: Urban Studies, Jg. 35, No. 7, S. 1059–1076.

Clark, William A. V.; Huang, Youqin; Withers, Suzanne (2003): Does commuting distance matter? Commuting tolerance and residential change. In: Regional Science and Urban Economics, Jg. 33, No. 2, S. 199–221.

DaVanzo, Julie (1983): Repeat Migration in the United States: Who Moves Back and Who Moves On? In: The Review of Economics and Statistics, Jg. 65, No. 4, S. 552–559.

Frost, Martin; Linneker, Brian; Spence, Nigel (1998): Excess or wasteful commuting in a selection of British cities. In: Transportation Research Part A: Policy and Practice, Jg. 32, No. 7, S. 529–538.

Giuliano, Genevieve; Small, Kenneth A. (1993): Is the Journey to Work Explained by Urban Structure? In: Urban Studies, Jg. 30, No. 9, S. 1485–1500.

Glaeser, Edward L.; Gottlieb, Joshua D. (2009): The Wealth of Cities: Agglomeration Economies and Spatial Equilibrium in the United States. In: Journal of Economic Literature, Jg. 47, No. 4, S. 983–1028.

Gobillon, Laurent; Selod, Harris; Zenou, Yves (2007): The Mechanisms of Spatial Mismatch. In: Urban Studies, Jg. 44, No. 12, S. 2401–2428.

Groot, Stefan P. T.; De Groot, Henri L. F.; Veneri, Paolo (2012): The Educational Bias in Commuting Patterns: Micro-Evidence for the Netherlands. Tinbergen Institute Discussion Paper, 12-080/3, S. 1–27.

Gutiérrez-i-Puigarnau, Eva; Mulalic, Ismir; Van Ommeren, Jos N. (2014): Do rich households live farther away from their workplaces? In: Journal of Economic Geography, online first, doi: 10.1093/jeg/lbu046.

Haas, Anette (2000): Regionale Mobilität gestiegen. IAB-Kurzbericht, 4/2000.

Haas, Anette; Hamann, Silke (2008): Pendeln - ein zunehmender Trend, vor allem bei Hochqualifizierten. IAB-Kurzbericht, 6/2008.

Haas, Anette; Osland, Liv (2014): Commuting, Migration, Housing and Labour Markets: Complex Interactions. In: Urban Studies, Jg. 51, No. 3, S. 463–476.

Hamilton, B. W.; Röell, Alisa (1982): Wasteful Commuting. In: Journal of Political Economy, Jg. 90, No. 5, S. 1035–1053.

Handel, Michael J. (2003): Skills Mismatch in the Labor Market. In: Annual Review of Sociology, Jg. 29, No. 1, 135–165.

Handy, Susan (1996): Methodologies for exploring the link between urban form and travel behavior. In: Transportation Research Part D: Transport and Environment, Jg. 1, No. 2, S. 151–165.

Hofmeister, Heather; Schneider, Norbert F. (2010): Job Mobilities in Europe: Core Findings, Policy Implications and Future Outlook. In: Schneider, Norbert F.; Collet, Beate (eds.): Mobile Living Across Europe II. Causes and Consequences of Job-Related Spatial Mobility in Cross-National Comparison. Opladen: Barbara Budrich, S. 337–356

Holzer, Harry J. (1991): The Spatial Mismatch Hypothesis: What Has the Evidence Shown? In: Urban Studies, Jg. 28, No. 1, S. 105–122.

Horner, Mark W.; Murray, Alan T. (2002): Excess Commuting and the Modifiable Areal Unit Problem. In: Urban Studies, Jg. 39, No. 1, S. 131–139.

Jovanovic, Boyan (1979): Job Matching and the Theory of Turnover. In: Journal of Political Economy, Jg. 87, No. 5, Part 1, S. 972–990.

Kain, John F. (1992): The Spatial Mismatch Hypothesis: Three Decades Later. In: Housing Policy Debate, Jg. 3, No. 2, S. 371–460.

Kain, John F. (1968): Housing Segregation, Negro Employment, and Metropolitan Decentralization. In: The Quarterly Journal of Economics, Jg. 82, No. 2, S. 175–197.

Kalleberg, Arne L. (2008): The Mismatched Worker: When People Don't Fit Their Jobs. In: Academy of Management Perspectives, Jg. 22, No. 1, S. 24–40.

Kalter, Frank (1994): Pendeln statt Migration? Die Wahl und Stabilität von Wohnort-Arbeitsort-Kombinationen. In: Zeitschrift für Soziologie, Jg. 23, No. 6, S. 460–476.

Kleinert, Corinna; Matthes, Britta; Antoni, Manfred; Drasch, Katrin; Ruland, Michael; Trahms, Annette (2011): ALWA – New Life Course Data for Germany. In: Schmollers Jahrbuch, Jg. 131, No. 4, S. 625–634.

Manning, Alan (2003): The real thin theory: monopsony in modern labour markets. In: Labour Economics, Jg. 10, No. 2, S. 105–131.

Merriman, David; Ohkawara, Toru; Suzuki, Tsutomu (1995): Excess Commuting in the Tokyo Metropolitan Area: Measurement and Policy Simulations. In: Urban Studies, Jg. 32, No. 1, S. 69–85.

Mulalic, Ismir; Van Ommeren, Jos N.; Pilegaard, Ninette (2014): Wages and commuting: Quasi-natural experiments' evidence from firms that relocate. In: The Economic Journal, Jg. 124, S. 1086-1105.

Mundlak, Yair (1978): On the Pooling of time-series and cross-section data. In: Econometrica, Jg. 46, No. 1, S. 69–85.

Muth, Richard F. (1969): Cities and Housing. Chicago, USA: University of Chicago Press.

Ng, Chen Feng (2008): Commuting distances in a household location choice model with amenities. In: Journal of Urban Economics, Jg. 63, No. 1, S. 116–129.

Oesch, Daniel (2013): Occupational change in Europe: how technology and education transform the job structure. Oxford: Oxford University Press.

Östh, John; Lindgren, Urban (2012): Do Changes in Gdp Influence Commuting Distances? A Study of Swedish Commuting Patterns between 1990 and 2006. In: Tijdschrift voor economische en sociale geografie, Jg. 103, No. 4, S. 443–456.

Preston, Valerie; McLafferty, Sara (1999): Spatial mismatch research in the 1990s: progress and potential. In: Papers in Regional Science, Jg. 78, No. 4, S. 387–402.

Puga, Diego (2010): The Magnitude and Causes of Agglomeration Economies. In: Journal of Regional Science, Jg. 50, No. 1, S. 203–219.

Reichelt, Malte (2015): Using longitudinal wage information in linked data sets. FDZ-Methodenreport, 01/2015.

Reichelt, Malte; Abraham, Martin (2015): Occupational and regional mobility as substitutes: A new approach to understanding job changes and wage inequality. IAB-Discussion Paper, 14/2015.

Rouwendal, Jan (1999): Spatial job search and commuting distances. In: Regional Science and Urban Economics, Jg. 29, No. 4, S. 491–517.

Rouwendal, Jan; Rietveld, Piet (1994): Changes in Commuting Distances of Dutch Households. In: Urban Studies, Jg. 31, No. 9, S. 1545–1557.

Small, Kenneth A.; Song, Shunfeng (1992): Wasteful Commuting: A Resolution. In: Journal of Political Economy, Jg. 100, No. 4, S. 888–898.

Taylor, Brian D.; Ong, Paul M. (1995): Spatial Mismatch or Automobile Mismatch? An Examination of Race, Residence and Commuting in US Metropolitan Areas. In: Urban Studies, Jg. 32, No. 9, S. 1453–1473.

Travisi, Chiara M.; Camagni, Roberto; Nijkamp, Peter (2010): Impacts of urban sprawl and commuting: a modelling study for Italy. In: Journal of Transport Geography, Jg. 18, No. 3, 382–392.

Van Ommeren, Jos N.; Fosgerau, Mogens (2009): Workers' marginal costs of commuting. In: Journal of Urban Economics, Jg. 65, No. 1, S. 28–47.

Van Ommeren, Jos N.; Gutiérrez-i-Puigarnau, Eva (2011): Are workers with a long commute less productive? An empirical analysis of absenteeism. In: Regional Science and Urban Economics, Jg. 41, No. 1, S. 1–8.

Van Ommeren, Jos N.; Rietveld, Piet; Nijkamp, Peter (1999): Job Moving, Residential Moving, and Commuting: A Search Perspective. In: Journal of Urban Economics. Jg. 46, No. 2, S. 230-253.

Van Ommeren, Jos N.; Rietveld, Piet; Nijkamp, Peter (1997): Commuting: In Search of Jobs and Residences. In: Journal of Urban Economics. Jg. 42, No. 3, S. 402–421.

Van Ommeren, Jos N.; van der Straaten, J. Willemijn (2008). The effect of search imperfections on commuting behaviour: Evidence from employed and self-employed workers. In: Regional Science and Urban Economics, Jg. 38, No. 2, S. 127–147.

Viry, Gil; Kaufmann, Vincent; Widmer, Eric D. (2009): Social Integration Faced with Commuting: More Widespread and Less Dense Support Networks. In: Ohnmacht, Timo; Maksim, Hanja; Bergman, Manfred Max (eds.): Mobilities and Inequality. England: Ashgate Publishing Limited.

Wallerstein, Michael; Golden, Miriam; Lange, Peter (1997): Unions, Employers' Associations, and wage-setting institutions in Northern and Central Europe, 1950-1992. In: Industrial and Labor Relations Review, Jg. 50, No. 3, S. 379–401.

White, Michelle J. (1988): Location Choice and Commuting Behavior in Cities with Dezentralized Employment. In: Journal of Urban Economics, Jg. 24, No. 2, S. 129–152.

Appendix

Table 4
Descriptive statistics: Observations entering multivariate analyses

Independent variables	Mean	Std. Dev.	Min	Max
Employment density (centred)	-1.158	3.565	-3.345	18.920
$\ln(\overline{w})$	0.011	0.428	-1.555	1.044
$\ln(\Delta\, w)$	0.002	0.140	-1.323	0.818
Unemployment rate in county	10.130	4.540	2.044	27.160
Change in number of employees in county	-0.002	0.021	-0.105	0.094
Second employment spell	0.004	0.061	0	1
Nationality: German	0.980	0.140	0	1
Education				
No schooling degree	0.003	0.056	0	1
Lower secondary	0.223	0.416	0	1
Medium secondary	0.372	0.483	0	1
Upper secondary	0.402	0.490	0	1
Second chance education	0.402	0.490	0	1
Family status				
Single	0.260	0.439	0	1
Living with partner	0.130	0.337	0	1
Living with married partner	0.610	0.488	0	1
Formal training				
No formal training	0.029	0.168	0	1
Vocational training	0.713	0.452	0	1
Academic training	0.258	0.437	0	1
Age in years	35.960	6.725	18.170	52.330
Sex: Female	0.265	0.442	0	1
Industrial sector				
Education, health and other services	0.384	0.486	0	1
Manufacturing and agricultural	0.048	0.213	0	1
Public Services	0.102	0.303	0	1
Construction	0.101	0.302	0	1
Trade	0.044	0.204	0	1
Transport	0.058	0.235	0	1
Financial intermediation and real estate	0.263	0.440	0	1
Working in public sector	0.109	0.311	0	1
Children in household (ref: none)				
0-3	0.150	0.357	0	1
3-6	0.155	0.362	0	1
6-18	0.362	0.481	0	1
Over 18	0.071	0.257	0	1
Partner with higher schooling degree	0.551	0.497	0	1
Residence duration in years	19.280	13.780	0	51.920
East Germany (without East Berlin)	0.144	0.351	0	1
Number of groups	250	250	250	250

Source: ALWA-ADIAB, restricted sample, n=1,023; years 1993-2008

Table 5
Complete mixed-effects models

Explanatory Variables	Dependent Variable: ln commuting distance				
	Model 1: Null Model	Model 2: Null model with wage effects	Model 3: Controls model (wage main effects)	Model 4: Controls model (wage interaction effects)	Model 5: Structural controls
Employment density	-0.013*	.-0.019**	-0.022**	-0.017*	-0.023**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
$\ln(\overline{w})$		0.207***	0.089***	0.186*	0.181*
		(0.056)	(0.071)	(0.074)	(0.075)
$\ln(\overline{w})$ * Employment density				0.074***	0.075***
				(0.014)	(0.014)
$\ln(\Delta\, w)$		0.075***	0.070***	0.122***	0.123***
		(0.009)	(0.009)	(0.009)	(0.009)
$\ln(\Delta\, w)$ * Employment density				0.037***	0.037***
				(0.003)	(0.003)
Unemployment rate					-0.004***
					(0.001)
Change in number of employees					-0.580***
					(0.148)
Unemployment rate * Change in number of employees					0.049***
					(0.011)
Second employment relation			-0.181***	-0.186***	-0.186***
			(0.022)	(0.022)	(0.022)
Nationality: German			0.135	0.136	0.131
			(0.162)	(0.163)	(0.163)
Education (ref: No degree)					
Lower secondary			0.623	0.608	0.600
			(0.345)	(0.347)	(0.347)
Medium secondary			0.683*	0.665	0.661
			(0.345)	(0.346)	(0.347)
Upper secondary			0.811*	0.778*	0.775*
			(0.346)	(0.347)	(0.348)
Second chance education			-0.113	-0.113	-0.115
			(0.084)	(0.085)	(0.085)
Family status (ref: single)					
Living with partner			0.017*	0.019*	0.019*
			(0.008)	(0.008)	(0.008)
Living with married partner			0.017*	0.018*	0.017*
			(0.008)	(0.008)	(0.008)
Formal training (ref: vocational)					
No training			-0.104	-0.117	-0.116
			(0.128)	(0.129)	(0.129)
Academic			0.023	0.024	0.027
			(0.017)	(0.017)	(0.017)
Age in years			0.002	0.002	0.002
			(0.004)	(0.004)	(0.004)
Sex: Female			0.015	0.013	0.011
			(0.056)	(0.056)	(0.056)

Explanatory Variables	Dependent Variable: ln commuting distance				
	Model 1: Null Model	Model 2: Null model with wage effects	Model 3: Controls model (wage main effects)	Model 4: Controls model (wage interaction effects)	Model 5: Structural controls
Industrial sector (ref: Manufacturing and agricultural)					
Public Services			-0.030	-0.023	-0.022
			(0.017)	(0.017)	(0.017)
Construction			0.004	0.001	-0.001
			(0.011)	(0.011)	(0.011)
Trade			-0.171***	-0.170***	-0.171***
			(0.010)	(0.010)	(0.010)
Transport			-0.107***	-0.110***	-0.110***
			(0.017)	(0.017)	(0.017)
Financial intermediation and real estate			-0.045*	-0.049**	-0.051**
			(0.018)	(0.018)	(0.018)
Education, health and other services			-0.202***	-0.197***	-0.198***
			(0.009)	(0.009)	(0.009)
Working in the public sector			0.033**	0.032**	0.033**
			(0.011)	(0.011)	(0.011)
Children in household (ref: none)					
0-3			-0.048***	-0.047***	-0.047***
			(0.004)	(0.004)	(0.004)
3-6			-0.016***	-0.014***	-0.014***
			(0.003)	(0.003)	(0.003)
6-18			-0.005	-0.004	-0.003
			(0.004)	(0.004)	(0.004)
Over 18			-0.027***	-0.027***	-0.025***
			(0.006)	(0.006)	(0.006)
Partner with higher qualification			0.001	-0.002	-0.002
			(0.009)	(0.009)	(0.009)
Residence duration in years			0.001	0.001	0.001
			(0.001)	(0.001)	(0.001)
East Germany		-0.593***	-0.563***	-0.568***	-0.565***
		(0.024)	(0.024)	(0.024)	(0.024)
Constant	2.822***	2.937***	2.108***	2.119***	2.159***
	(0.035)	(0.040)	(0.374)	(0.376)	(0.376)
Individual controls			✓	✓	✓
v_r County constant	0.358***	0.459***	0.441***	0.435***	0.450***
u_{ir} Person constant	0.707***	0.686***	0.700***	0.704***	0.704***
N Counties (level 3)			250		
N Persons (level 2)			1,023		
N Observations (level1)			83,697		

Note on significance levels: ***p≤0.001 **p≤0.01 *p≤0.05; Standard errors in parentheses

Source: ALWA-ADIAB, own calculations, restricted sample, n=1,023; years 1993-2008

Recently published

No.	Author(s)	Title	Date
18/2015	Möller, J.	Verheißung oder Bedrohung? Die Arbeitsmarktwirkungen einer vierten industriellen Revolution	6/15
19/2015	Hecht, V.	Location choice of German multinationals in the Czech Republic: The importance of agglomeration economies	7/15
20/2015	Wiemers, J.	Endogenizing take-up of social assistance in a microsimulation model: A case study for Germany	7/15
21/2015	Wanger, S. Weigand, R. Zapf, I.	Measuring hours worked in Germany: Contents, data and methodological essentials of the IAB working time measurement concept	8/15
22/2015	Weigand, R. Wanger, S. Zapf, I.	Factor structural time series models for official statistics with an application to hours worked in Germany	8/15
23/2015	Zapf, I.	Who profits from working-time accounts? Empirical evidence on the determinants of working-time accounts on the employers' and employees' side	8/15
24/2015	Dietrich, H.	Jugendarbeitslosigkeit aus einer europäischen Perspektive: Theoretische Ansätze, empirische Konzepte und ausgewählte Befunde	9/15
25/2015	Christoph, B.	Empirische Maße zur Erfassung von Armut und materiellen Lebensbedingungen: Ansätze und Konzepte im Überblick	9/15
26/2015	Bauer, A.	Reallocation patterns across occupations	9/15
27/2015	Dauth, W. Fuchs, M. Otto, A.	Long-run processes of geographical concentration and dispersion: Evidence from Germany	9/15
28/2015	Klinger, S. Weber, E.	Detecting unemployment hysteresis: A simultaneous unobserved components model with Markov switching	10/15
29/2015	Eckman, S. Kreuter; F.	Misreporting to looping questions in surveys: Recall, motivation and burden	10/15
30/2015	Lehmann, R. Weyh, A.	Forecasting employment in Europe: Are survey results helpful?	11/15
31/2015	Umkehrer, M.	The impact of changing youth employment patterns on future wages	11/15
32/2015	Fuchs, J. Weber, E.	Long-term unemployment and labor force participation: A decomposition of unemployment to test for the discouragement and added worker hypotheses	11/15

As per: 2015-11-19

For a full list, consult the IAB website
http://www.iab.de/de/publikationen/discussionpaper.aspx

Imprint

IAB-Discussion Paper 33/2015
20 November 2015

Editorial address
Institute for Employment Research
of the Federal Employment Agency
Regensburger Str. 104
D-90478 Nuremberg

Editorial staff
Regina Stoll, Jutta Palm-Nowak

Technical completion
Gertrud Steele

Website
http://www.iab.de

Download of this Discussion Paper
http://doku.iab.de/discussionpapers/2015/dp3315.pdf

ISSN 2195-2663

For further inquiries contact the authors:

Malte Reichelt
Phone +49.911.179 3349
E-mail malte.reichelt@iab.de

Anette Haas
Phone +49.911.179 3088
E-mail anette.haas@iab.de