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How to Woo the Smart Ones?
Evaluating the Determinants that Particularly Attract Highly Qualified People to Cities

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Abstract

Human capital is a driving factor of innovation and economic growth. Economic prospects of cities depend on high qualified workers' knowledge and therefore, attracting highly qualified workers plays a fundamental role for cities' prospects. This study contributes to the question which factors primarily determine the mobility-decision of highly qualified workers by investigating the determinants of the migration balance of German cities between 2000 and 2010. Furthermore, it compares the effects of several labour- and amenity-related variables on migration rates of highly qualified workers and the remaining workforce. Findings suggest that local labour market conditions influence the mobility decision but amenities matter too for the high-skilled. The preferences of the highly qualified workers partly differ from those of the rest of the workforce. However, there are also several factors that do not show systematic differences across skill groups.

Key Words: migration, cities, qualification level, highly qualified, labour market conditions, amenities, Germany

JEL: C23, J61, R23

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1 Introduction

A high share of well-educated workers is a key competitive asset for regions' prospects (Moretti 2004). Human capital stimulates productivity, the process of innovation (Niedomysl and Hansen 2010) and therefore determines region's economic growth (Glaeser et al. 1995). Abel and Gabe (2011) show that a 1 percentage point increase in the proportion of residents with a college degree is associated with an increase of about 2% in U.S. metropolitan area GDP per capita (see Falck et al. 2011 for similar results with German data). In the process of structural change, particularly cities develop a knowledge-based economy and thus their labour demand relies more on human capital than labour demand of most rural areas (Glaeser and Maré 2001).

In fact, the importance of a well-educated population[1] for cities is even rising (Glaeser and Gottlieb 2006), but a closer look bares huge differences in the educational level of cities. As for the U.S., there are metro areas like Washington, San Francisco or Boston, where more than 40% of the adult residents had a college degree in 2010. In other metro areas, like El Paso or Modesto, less than a fifth of inhabitants had an academic education (Rothwell 2012). The differences between the smartest metro areas and those ones left behind have even become larger in the past four decades (ibid; see also Berry and Glaeser 2005, Moretti 2004). There are likewise huge differences in Europe. In U.K., e.g., the agglomeration of London had a share of about 32% highly educated people while the share in Liverpool is just about 20% in 2010. In France, nearly 47% of Paris' population is highly educated but not more than 25% of Marseille's inhabitants (Eurostat 2014).

The degree of cities' human capital endowment is mainly driven by migration flows (Chen and Rosenthal 2008, Krabel and Flöther 2012). Determining the differences in cities educational level, highly qualified show the highest mobility rates. This selectivity of mobility holds true for the German context, too (Arntz 2007). We observe that not only within-country migration in Germany is pronounced – in particular, between East and West Germany (Buch et al. 2014), but also that the mobility rates for highly qualified are two times higher as compared to other groups. Moreover, huge differences in the share of high qualified workforce are notable. Among the cities with more than 100,000 inhabitants, the

[1] Glaeser et al. (1995) and Poelhekke (2013) for the German case however stress that not only the top of the education distribution is crucial but a favourable qualification structure of the whole labour force is also important.

average share of high qualified employees from 1999 to 2009 varies between about 5% in the city of Salzgitter which is characterized by a relatively monolithic industrial profile and more than 31% in the university town of Heidelberg. On average, the share of highly qualified employees in cities has risen in the period under consideration by nearly five percentage points to more than 17%. At the same time, the gap of cities' share of high educated workers to the share in rural area has risen (from 6.0 in 1999 to 8.2 percentage points in 2009) in Germany, too.

In light of the huge differences in human capital endowment in cities and given the decisive impact of the mobility of highly qualified in this context, the question arises, which factors primarily determine a mobility-decision in favour of a special city and to the disadvantage of another? Migration decisions generally result from the evaluation of local labour market conditions and location-specific amenities. But which particular role do these factors have in attracting highly qualified people? Many authors note that – although amenities have an influence – labour market conditions are crucial (e.g. Miguélez and Moreno 2014, Brown and Scott 2012, Scott 2010, Dorfman et al. 2011). On the other hand, e.g. Glaeser et al. (2001, p. 29) are convinced that "traditional cities will only succeed when they provide amenities that are attractive to high human capital residents".

This study aims at contributing to the ongoing debate by adding some systematic empirical evidence on the factors that determine cities' net labour migration regarding highly educated people. We use the example of German cities in the period from 2000 to 2010. We analyse the impact of several labour- and amenity-related factors on migration rates of the highly skilled workforce. Additionally, we investigate if factors that influence the migration rates of the highly qualified differ from the factors that determine the outcome for the rest of the workforce. There is – mainly due to data restrictions – only exceptional evidence on this aspect. Dalmazzo and de Blasio (2011) present with Italian data one of the rare exceptions. Niedomysl and Hansen (2010) investigate with Swedish survey data the importance of different job-amenity-related factors for migration decision of high qualified and other workers. Brown and Scott (2012) examine this question for workers in Canada and Zheng (2014) for U.S. metropolitan areas. Besides, we do not just consider general (labour market) conditions but focus on skill specific conditions, because general conditions are not always a good approximation of skill specific conditions. Furthermore, we concentrate on cities' *labour migration.* Most previous studies have focused typically on mobility of the

overall population (see Brown and Scott 2012 for a similar argument), if mobility is respected for at all. A great deal of analysis concerning the spatial distribution of human capital, especially for the U.S., simply uses population growth as an indirect indicator for mobility (Miguélez and Moreno 2014). Examining *labour migration* as we do can provide more reliable results regarding the relative importance of labour market conditions and amenities.

To the best of our knowledge, there is hardly any evidence with a wide range of job- and amenity-related factors and in addition none with German data.[2] Moreover, we investigate some aspects of the migration of highly skilled that have not received that much attention in the previous literature, such as differences between changes of residence, changes of the workplace and combination of both.

For the analysis of skill-specific urban labour migration and its determinants, Germany provides a particularly interesting example. Regional disparities in labour market performance are as striking as they are persistent. The endowment of amenities differs widely across cities, and as mentioned earlier there are huge differences in both: the share of highly qualified and the migration rates of cities.

The paper is organised as follows. The next section provides a brief survey of the theoretical and empirical literature on labour mobility. Section 3 describes the data. In section 4 the econometric analysis is presented. We discuss the results of the regression analysis in section 5. Section 6 concludes the paper.

2 Literature

According to Migration theory locational characteristics acting as push or pull factors can be divided into labour market conditions, such as (un)employment and wage levels and amenities, such as natural attractiveness, consumer facilities and public goods (e.g. Rodriguez-Pose and Ketterer 2012)

However, the debate on the main general determinants of migration flows has not come to an end yet. Some authors stress the importance of labour market conditions (see e. g. Shapiro 2006 or Scott 2010), others emphasise the relevance of amenities (Mueser and

[2] The focus of the study of Arntz (2010) dealing with the question what attracts skilled workers in Germany is not on cities but on spatial skill sorting valued in light of remaining regional disparities between Eastern and Western Germany. She concentrates on changes of workplace. This type of mobility is not necessarily a good approximation of overall mobility.

Graves 1995 or Glaeser and Gottlieb 2006). And there is even less a consensus on the specific importance of labour market conditions and amenities for migration decisions of the highly qualified who are of special importance for the prospects of cities.

Regarding labour market aspects it can be followed from Borjas (1992) that high-skilled workers are primarily attracted by regions that are adequate to maximize their income. Brown and Scott (2012) also stress the role of labour market aspects in comparison to amenities for degree holders' location choices. But other authors like Nifo and Vecchione (2013) and Dalmazzo and de Blasio (2011) detect that the sources of urban attractiveness, especially for the more educated, have to do both with better chances to find a satisfactory job in a large labour market, and with the wide availability of consumption amenities. In addition, Carlino and Saiz (2008) present results that indicate that leisure amenities could be successful in attracting high-skilled individuals to a city and Glaeser et al. (2001) also emphasize the meaning of factors that are beyond the labour market. However, we have a chicken and egg problem here: we do not know whether an increase in the demand for skilled labour in a city results in an increase in the number of college educated residents in that city and this in turns results in increases in the local amenities that are highly demanded by college graduates, or whether local amenities – and not primarily labour demand – do in fact have the power to attract highly educated inhabitants (Storper and Manville 2006).

Regarding the meaning of determinants of migration compared for different skill groups analyses on the one hand are scarce and on the other hand the results are inconsistent. Following theoretical arguments, highly qualified migrants should place greater value on amenities than workers with less education, because the marginal utility of rising income high qualified persons could attain declines and accordingly the relative importance of local amenities should increase (see e.g., Graves and Linneman 1979, Knapp and Graves 1989). Other authors argue that an increase in the demand for amenities will be simply driven by higher income. Since the educated earn more on average than the less educated, the educated will demand more amenities even without any preference bias (see, e.g., Roback 1988).

However, regarding the impact of amenities the idea that the skilled seem to enjoy some urban amenities more than the unskilled has found empirical support in the U.S. case.[3] In sum, there is some evidence that cities' amenities seem to be more important for highly educated people than for the less educated ones (see also Moretti 2013).

A variety of amenities and their relevance for mobility decisions of highly and less skilled people is discussed in literature.

Highly educated people appear, for example, to care more about the availability of cultural amenities like the concentration of cinemas, theatres, and museums than the less-educated (see, e.g., Shapiro 2006, Buettner and Janeba 2013, Dalmazzo and de Blasio 2011). The highly educated also seem to benefit more from the wide array of urban shopping possibilities (Dalmazzo and de Blasio 2011). A good public transportation system that significantly reduces commuting times might be quite appealing to high-skilled workers due to their greater opportunity costs of time (Adamson et al. 2004).

Ethnic diversity may likewise be more attractive for highly educated people as it is likely linked to a diversified supply of goods and services, i.e., urban consumption externalities like ethnic markets and restaurants. Moreover, ethnic diversity may be considered as a proxy for a climate of tolerance[4] and openness (an openness to all kinds of diversity) – urban characteristics that are particularly attractive to the "creative class" (Florida 2004). A diverse culture may, however to some extent, be preferred by high-human capital workers due to their segregation options: Affluent residents "are able to isolate themselves from people of other cultures via the buildings they live in, the schools to which they send their children and their use of private automobiles rather than public transport" (Storper and Manville 2006, p. 1256).[5] The less educated, less wealthy population has a higher risk that mixed residence means problems, at home, at school and in leisure.

Good schools also appear to be important to attract highly educated workforce (Glaeser et al. 2001). Regarding the availability of child care facilities, Arntz (2010) shows that this amenity has an impact only on high-skilled job movers.

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[3] Otherwise, Carlsen and Leknes (2013) conclude for the case of Norwegian regions that there is a broad consensus between educational groups in evaluating amenities and disamenities of city living.

[4] In contrast, Qian (2013) suggests to distinguish the two concepts, because it is tolerance but not necessarily diversity that is decisive for talent attraction.

[5] Peeters (2008) finds for Belgian municipalities that high income people (who are normally highly qualified) sort themselves into specific locations and seem to have a tendency to reside near people with similar income positions.

The influence of natural amenities on the migration probability is in general positive (Chi and Marcouiller 2011, Dorfman et al. 2011, Wang and Wu 2011). Arntz (2010) states that climatic characteristics seem to be more important for high-skilled than for less-skilled job movers. As against this results Brown and Scott (2012) find that the relevance of climate variables for location choices of degree holders is smaller than for non-degree holders.

The expected impact of population density is in general not clear-cut (Glaeser and Gottlieb 2006). On the one hand, high population density might reflect significant congestion and pollution costs and result in less net migration (see e.g. Brown and Scott 2012). On the other hand, high population density can correspond with positive agglomeration effects, such as dense interpersonal communication (Glaeser 2012) worker interaction and knowledge transfers. Krabel and Flöther (2012) find some support for the urban size argument with respect to German graduates and Dalmazzo and de Blasio (2011) confirm that the more educated have a preference bias towards city size.

Regarding the impact of housing, Korpi et al. (2010) analyze the interaction of housing expenditure, rental fees and migration in Sweden and differentiate between different income groups. For the group of high income earners to which the high qualified generally belong to, expansive urban dwelling is a type of luxury consumption while for low income groups expensive housing have adverse effects on migration.

Literature also discusses a skill-bias in adverse response regarding some disamenities. More-educated workers may shun cities with high crime rates more than less educated ones (Cullen and Levitt 1999).[6] Highly educated seems to be annoyed by noise pollution more than the less educated workers (Dalmazzo and de Blasio 2011).

There is some evidence on regional (but not always explicit city-) characteristics determining migration flows of highly skilled workers in Germany. Concentrating on mobility of university graduates, Krabel and Flöther (2012) reveal that besides the absorptive capacity (share of highly qualified employees) in a region, social ties to employer are crucial for a mobility decision. Arntz (2010) finds that internal migration flows of high-skilled individuals are mainly driven by interregional income differentials, while job matches by less-skilled individuals are mainly affected by regional differences in unemployment. According to her study, interregional differences in wage dispersion as well as amenity differentials only

[6] Dalmazzo and de Blasio (2011) however find that crime is likely to affect all residents.

relatively weakly contribute to spatial sorting processes. In a more recent study, Arntz et al. (2013) show that the skill composition of labour flows is mainly driven by regional differences in the employment rather than the wage distribution. According to this study, a region attracts an increasingly skilled inflow of migrants, the higher its average employment rate (i.e. the lower its unemployment rate) is. The same is true for an increasing inequality in employment chances. In contrast to evidence for the U.S. (e.g., Borjas et al. 1992) and in line with Arntz (2010), regional differentials in the wage distribution exert no significant effect on the skill composition of labour flows in Germany. This may be due to the fact that regional disparities in wages are not very pronounced because of the centralised bargaining system.[7]

While according to Arntz (2010) and Arntz et al. (2013) labour market related issues are of capital importance, Buettner and Janeba (2013) focus on cultural amenities.[8] To test for the effect of cultural amenities on location decisions, they combine the data on public spending for theatres in German cities with data on individual earnings. They find that the local subsidization of theatres is effective in attracting highly educated people.

Summing up, the literature review bares a number of open questions regarding the main determinants of cities‘ attractiveness for high-skilled migrants. Neither is a clear-cut answer given yet on the question whether jobs or amenities dominate migration decisions of the high-skilled nor is a probably different weight of these main pillars for different skill groups defined. Besides labour market indicators, we investigate the relative impact of a great variety of (dis)amenities for mobility decisions of high qualified German workers.

3 Data

The analysis of the migration rates of highly qualified workers in German cities rests on a panel data set that covers the period from 2000 to 2010. Annual information on migration flows and their potential determinants is available on the NUTS 3 level (counties). We focus on the explanation of the migration balance of 69 German cities with at least 100,000

[7] Borjas et al. (1992) and Hunt and Mueller (2004) demonstrate for the U.S. that regions with a high wage inequality attract skilled workers more than regions with the same average wage level, but a lower wage inequality.

[8] In their analysis, Buettner and Janeba (2013) incorporate both amenities and labour market conditions of German counties. Analysing how differences in amenities and wages do capitalize in differences in land prices and wages as a measure for the quality of life they however have a different analytical focus.

inhabitants, 58 of them are located in West Germany and 11 in East Germany.[9] City size varies between 100,000 in Trier and 3.4 million in Berlin.

We use the employee history of the Institute for Employment Research (IAB) to generate our migration data. The employee history provides detailed information on workers, and in particular on their county of residence, their workplace and their level of educational attainment. The data set allows us to distinguish between four groups of workers: low-skilled workers (no formal vocational qualification), medium-skilled workers (completed apprenticeship training), high-skilled workers (university degree/college of higher education degree) and workers with no information on their qualification level. The IAB employee history includes all employees covered by the social security system.[10] As this data set covers the majority of employment in Germany (about 70 percent) our migration data should be representative with respect to labour mobility. We focus on two groups of workers in our analysis, namely the highly-skilled workers and the remaining workforce. The latter group corresponds to the sum of medium-, low-skilled workers and those with no information on their qualification level.

Migration is defined as the change of residence and/or workplace of employees between two reference dates (June 30 of present and previous year). We differentiate between three definitions of migration in the analysis:

- Definition 1: moves that involve both change of residence and workplace
- Definition 2: moves that involve a change of workplace
- Definition 3: moves that involve a change of residence

To investigate the impact of various push and pull factors on labour mobility we use different data sources. Information on the main labour market indicators, i.e. skill specific regional wage level, unemployment rate and employment growth[11] are taken from the employee history and the unemployment statistic of the Federal Employment Agency (FEA). The wage level is measured as the 40% percentile[12] of the distribution of daily wages in the

[9] Two cities with more than 100,000 inhabitants (Hannover and Herne) are not included in our analysis due to data restrictions.

[10] Self-employed, family workers, and civil servants are not included.

[11] This variable is defined as the average employment growth in the preceding 3 years and is used as a proxy for regions' job opportunities.

[12] This percentile is used to avoid bias due to the fact that individual wage information is trimmed at the security threshold. For more information, see Table A.1 in the Appendix.

city. Furthermore, we consider the start-up dynamics of regions by including the balance of start-ups and de-registrations.

Apart from labour market conditions we take into account urban amenities as a second group of factors that might explain differences in the migration balance of cities. Some leisure facilities might be particularly important for highly qualified workers. We approximate the cultural equipment of regions and other man-made amenities by indicators that use information on persons employed in restaurants and the number of theatre visitors. Following Boschma and Fritsch (2009), we also use a cultural opportunity index that captures the employment in cultural and recreational activities.[13] Furthermore, we include a number of social structure indicators like a cultural diversity index of the urban population, the share of foreigners, and the share of highly qualified workers.

Accessibility, the traffic infrastructure and educational facilities might also impact on the choice of residence of high skilled workers. Accessibility to international airports, motorways and high speed trains, a regional price index, average flat size and the number of students per 1,000 inhabitants are taken from the INKAR database by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR). We also consider population density as a proxy for positive or negative agglomeration effects that might influence the migration decision. Nature and weather characteristics like the share of recreation area, the average number of sunshine hours and the temperature are also included in the data set.[14] Finally, disamenities are captured by the number of criminal offenses and the amount of nitrogen dioxide emissions. For a detailed description of all considered variables and data sources see Table A.1 in the appendix.

The economic structure of agglomerations in Germany is characterized by a specialization in human-capital intensive service activities which makes the immigration of highly skilled workers particularly important for cities. However, the share of highly skilled workers considerably varies between cities. We observe the minimum share of highly skilled workers in the city of Salzgitter (4.57% in 2001) and the maximum share in the university town of

[13] Other cultural variables such as the share of employees in the creative sector and the number of artists give rise to results that resemble the estimates for the cultural opportunity index. Therefore we do not discuss the findings for the former variables in section 5.

[14] We also tested whether characteristics like proximity to the ocean, wind, cloud cover and precipitation impact on the migration balance. It turned out that these variables do not significantly influence the migration flows. Therefore, we refrain from presenting corresponding results in the paper. They are available from the authors upon request.

Heidelberg (37.17% in 2010). These different degrees of specialization may be explained by varying labour market conditions and a diverse range of amenities across cities. Furthermore, we observe an important variation across distinct definitions of migration. The pattern of migration flows that involve a change of workplace significantly differs from those flows that involve a change of residence as indicated by the correlation analysis summarized in Table 1. The correlation between urban migration rates that involve the change of workplace (definition 2) and the net migration rates that are based on the change of residence (definition 3), for example, is relatively low. This correlation varies between 0.27 for the remaining workforce and 0.30 for the highly-skilled workers. In addition, the correlation between the migrations rates of the highly-skilled workers and those of the remaining workforce is the lowest for definition 1 (change of residence and workplace) with 0.36 and amounts to a maximum of 0.57 for definition 3. Altogether, the results reveal huge disparities in the regional migration patterns both with respect to the definition of migration and as regards different skill groups.

[Table 1 around here]

A closer look at the average migration balances of individual cities between 2000 and 2010 shows a huge dispersion of the variable. For example, Fürth (+15.1‰) and Wolfsburg (+9.3‰) are particularly attractive for highly-skilled workers if we consider just the change of residence (definition 3). Cities that are the least attractive for highly-skilled workers are two West German cities, namely Kiel (-33.3‰) and Würzburg (-28.6‰). The remaining workforce is, however, more likely to leave citites that are located in East Germany. Halle (-14.0‰), Cottbus (-13.5‰) and Rostock (-11.6‰) exhibit the highest migration losses.

Further summary statistics of the migration rates and explanatory variables are listed in Table 2. Migration losses and gains seem to be more pronounced for the highly-skilled workers than for the remaining workforce. This is not only reflected by their overall range, but also by their standard deviation. These results correspond with empirical evidence on a relatively high propensity to migrate of workers with a university degree. The pronounced variation of the regional migration patterns suggest that the factors that significantly impact on labour mobility differ across definitions and skill levels.

[Table 2 around here]

Table 2 also points to important disparities with respect to potential determinants of labour mobility in our sample of German cities. For example, the average employment growth of the highly skilled workers varies between -6.90 in the eastern Germany city of Gera in 2004 and 17.88% in the western Germany city Wolfsburg in 2005. Furthermore, we detect the minimum and maximum level for the cultural opportunity index in the period under consideration among West German cities (Mainz: 100.69 per 1,000 employees in 2009; Salzgitter: 8.40 per 1,000 employees in 2008).

Summing up, the findings of the descriptive analysis demonstrate that cities are characterized by distinct labour market conditions and a range of amenities that potentially explain the differences in migration balances and the specialization in highly skilled workers across cities. This analysis further indicates that it makes sense to differentiate between skill groups and migration definitions in the regression analysis.

4 Econometric model

We apply the following regression model to identify factors that impact on the migration balance of high-skilled (hq) labour in German cities:

$$nmr_{it}^{hq} = \alpha + \sum_{k=1}^{K} \beta_k \, labourmarket_{kit-1} + \sum_{l=1}^{L} \gamma_l amenities_{lit-1} + \sum_{m=1}^{M} \varphi_m C_{mi} + \varepsilon_{it} \qquad (1)$$

The dependent variable is the net migration rate of workers with a university of city *i* in year *t,* i.e. the corresponding migration balance per 1,000 employees. We generally consider moves that involve a change of residence in the basic specification (migration definition 3). However, we also estimate models for migration flows that are accompanied by a change of the workplace. Moreover, the mobility of the remaining workforce is investigated in order to examine whether the factors that influences the choice of residence differ across skill groups. The white noise error term is given by ε_{it}.

The inclusion of explanatory variables is governed by a review of the migration literature. According to previous studies we can divide the explanatory variables into two broad groups of factors: labour market variables and indicators for urban (dis)amenities. The former group includes the wage level, the unemployment rate, the employment growth, and the balance of business registrations and de-registrations. In most specifications we apply skill-specific measures of the first three regressors, i.e. the average wage of high-skilled workers in the

city, unemployment of workers with a university degree and the corresponding employment growth. In order to investigate the influence of amenities we consider various measures of first and second nature amenities such as recreation areas, climatic conditions and accessibility. In particular, the set of explanatory variables comprises several indicators. In the pooled models, time-variant and time-invariant variables enter. C_{mi} denotes the latter group. All regressors are predetermined in order to account for potential endogeneity of the explanatory variables. We estimate a pooled version of the model and a panel specification that controls for city-specific effects δ_i.

There are some critical econometric issues in analysing the effects of various influential factors on city migration balance. The first one is the omitted variable bias that can result from the potential correlation between unobserved urban characteristics and the migration of high-skilled workers. We deal with unobserved time-invariant city characteristics by estimating a panel model that includes city fixed effects δ_i:

$$nmr_{it}^{hq} = \alpha + \sum_{k=1}^{K} \beta_k \, labourmarket_{kit-1} + \sum_{l=1}^{L} \gamma_l amenities_{lit-1} + \delta_i + \varepsilon_{it} \qquad (2)$$

A disadvantage of this specification is that it provides no evidence on the time-invariant factors C_{mi} because their influence is captured by δ_i. However, for the amenities that show a significant within variation we reduce the risk of bias caused by unobserved heterogeneity.[15]

A second econometric issue concerns the potential simultaneity bias resulting from reverse causality between the urban migration balance and some explanatory variables. In particular the estimated effects of labour market conditions on city migration balance are likely biased because labour migration may influence the urban unemployment rate, the wage level and employment growth.[16] Due to endogeneity of these variables, the relationship estimated by OLS cannot be interpreted as causal and the estimated effects are expected to be biased. We address this problem by using predetermined explanatory variables. However, relying only on predetermined variables seems inappropriate given the forward looking nature of the

[15] The fixed-effect estimator only exploits the within variation and leaves unused a significant part of information that is incorporated into the cross-sectional dimension of the explanatory variables. Fixed effects estimation, therefore, might results in weakly identified effects because the cross sectional variation cannot be used for identification (see Hausman and Taylor 1981). Especially variables that show a relatively low within variation will be affected by this drawback.

[16] Niebuhr et al. (2012) and Granato et al. (2015) provide corresponding evidence for German regions.

issue. Therefore we also apply instrument variable (IV) estimation focusing on the instrumentation of those variables that are most likely affected by simultaneity bias, i.e. the labour market indicators.

In the two-stage least squares (2SLS) estimation several instruments enter. The selection of IV is conditioned by the following considerations. First, we need a sufficient number of instruments to allow for overidentification and test the exogeneity of the IV. If we simultaneously instrument three labour market indicators, we need at least four IV. However, too many instruments may overfit the endogenous variables and lead to incorrect inferential decisions (Roodman 2009). Many instruments may fit the endogenous variable so well that the fitted values used in the second stage may still contain the endogenous component of variation and, thus, resulting in a bias.

Firstly, we consider time lags[17] of all endogenous variables as IV. Furthermore, in order to provide an additional instrument for the unemployment rate of high-skilled workers we use the skill-specific share of older workers (aged from 45 to 59) since older workers, especially those above 50 years of age, suffer from above average unemployment in Germany. And finally, to isolate exogenous changes in city employment we use a skill-specific shift share instrument. The employment growth is instrumented by a weighted average of nationwide employment growth in 86 occupation groups where the weights correspond with the city-specific employment share of occupation *j* in *t*-1 (ω_{ijt-1}). The instrument is given by:

$$\sum_{j=1}^{86} \omega_{ijt-1} \Delta E_{jt-1;t} \qquad (3)$$

where $\Delta E_{jt-1;t}$ is the nationwide change in employment in occupation group *j* between *t*-1 and *t*. If we consider two cities with distinct occupational composition, the region where jobs dominate that are marked by a countrywide increase (decline) are expected to experience a positive (negative) employment shock (see Moretti 2010).

Finally, cross-sectional dependence might adversely affect the regression results. We cannot presume that our cross-section of cities is a random sample of regions. The cities are likely subject to unobservable common disturbances that result in cross-sectional dependence. Provided that these common factors are uncorrelated with the explanatory variables, the

[17] These lags can vary between four and six years due to data restrictions.

coefficient estimates are unbiased, but standard error estimates are biased and hence statistical inference that is based on such standard errors is invalid. To deal with this issue we apply the nonparametric covariance matrix estimator introduced by Driscoll and Kraay (1998), which provides heteroscedasticity consistent standard errors that are robust to very general forms of cross-sectional and temporal dependence.

5 Regression results and discussion

In Table 3 we summarize some first results for the migration of high-skilled workers in Germany applying pooled regression models. We focus on migration flows that involve a change of the residence (definition 3). The pooled model provides evidence on the relevance of time-invariant factors that cannot be considered in the fixed effects specifications. Moreover, it is possible to investigate whether there are systematic differences between East and West German cities. The models in the columns (1) to (5) slightly differ with respect to included explanatory variables. The majority of the effects are fairly robust with respect to these changes of the specification.

[Table 3 around here]

We detect a number of highly significant effects. The estimates suggest that both labour market conditions and amenities influence the migration balance of German cities. All economic and labour market indicators impact on the mobility of workers with a university degree. In line with theoretical expectations, highly qualified labour tends to prefer cities that offer high wages and rising employment opportunities. This corresponds partly with previous evidence on the importance of labour market conditions for the migration of high-skilled workers. The findings of Arntz (2010) suggest, however, that the mobility of this group is mainly driven by interregional income differentials while unemployment and employment growth do not seem to matter. In contrast, our results indicate that the high-skilled consider the latter factors as well when deciding on the city of residence. These differences might be due to the fact that we include skill-specific labour market indicators in this analysis. Moreover, high-skilled workers tend to be attracted to urban areas that are characterized by a dynamic entrepreneurial activity as indicated by the positive coefficient of the business variable.

The results in Table 3 also point to an important role of different (dis)amenities. Several coefficients are highly significant and most signs correspond with theoretical arguments

discussed in section 2. In particular, there is evidence that infrastructure for leisure activities (see e.g. Carlino and Saiz 2008), and notably the availability of cultural facilities have a favourable impact on the urban migration balance of high-skilled workers. The share of restaurant workers has a positive and highly significant effect in all specifications. There is also some indication for a positive association between the cultural opportunity index and the net migration rate, though this result is less robust. In column (4), we also consider the number of theatre visitors per 10 inhabitants as an additional indicator for cultural facilities. This variable shows a positive correlation with the migration balance too and its inclusion does not adversely impact on the effects of the other cultural facility indicators.[18]

While the findings for cultural amenities are in line with arguments put forth in section 2, the results for the social structure of the city tend to be unexpected from a theoretical perspective. High-skilled workers seem to avoid urban regions that are characterized by a relatively high population share of well-educated people. Only in model (3) where we additionally include the number of students per 1,000 inhabitants this correlation does not show up. These results indicate that the significant negative coefficient of the share of highly qualified employees is somehow linked to tertiary education. In fact, we observe that several small cities with fairly large universities, such as Kiel, Heidelberg, and Würzburg are marked by strong out-migration of high-skilled workers. The effect might thus be driven by university graduates who tend to leave small university towns in Germany shortly after labour market entry in order to pursue a career in large urban labour markets that offer more favourable perspectives. We also detect a negative effect of the share of the foreign population on the urban migration while cultural diversity among the foreign workforce seems to increase the attractiveness of German cities for high-skilled workers. However, it is important to note that the negative correlations that we detect in the pooled models are not robust. Once we control for unobserved heterogeneity by including city fixed effects there is no significant negative influence of the corresponding population shares on net migration.

We also consider costs of living and housing conditions in the regression model by including the average rent per square meter and the flat size per capita in the cities. The availability of spacious flats tends to increase the attractiveness of urban areas. While this effect is rather robust across different specifications, we detect a significant and positive effect of the rent

[18] We do not consider the theatre visitors in other specifications because the inclusion of this variable significantly reduces the number of observations due to restricted data availability.

level only in some models. This result is partly in accord with Korpi et al. (2010) who found for the group of high income earners in Sweden to which the high qualified generally belong a positive impact of expansive urban dwelling because it is a type of luxury consumption.

In column (5) we substitute the rent level by a more comprehensive measure of urban costs of living. The positive and significant correlation between the city price index and the migration balance of high-skilled workers confirms findings for the rent level in the other columns of Table 3. The sign of these effects do, however, not correspond with standard migration models that emphasize the dampening effect of a high price level on utility and in-migration. We find that cities characterised by a relatively high price level tend to realise a rather strong net in-migration of workers with a university degree. Our results confirm corresponding evidence for the U.S. by Waldorf (2009). Buettner and Ebertz (2009) and Buch et al. (2014) provide similar evidence for German regions. According to Dahlberg et al. (2012) these results suggests that the regional price level reflects quality of life which is consistent with the idea that urban amenities capitalize into house prices.

Furthermore, there is evidence on disamenities that influence the utility of high-skilled workers and the choice of their residence. The negative impact of the crime rate corresponds well with theoretical expectations. Moreover, the negative coefficient of the population density points to adverse effects of agglomeration on the utility of high-skilled workers. This effect arises in all specification apart from column (2). In the latter model we include emissions of nitrogen dioxide that shows a significant negative correlation with the net migration rate (see for similar results Brown and Scott 2012). The adverse impact of the population density might therefore be mainly explained by the environmental impact of dense settlement and economic activity. In addition, a high volume of traffic as indicated by the access to motorways seems to reduce the attractiveness of urban areas.[19] However, the accessibility of traffic infrastructure is not an adverse factor per se. Access to an international airport seems to increase the average utility of high-skilled workers and net in-migration to the city. A positive impact of a public transportation system is also found by Adamson et al. (2004).

[19] The positive coefficient of motorway accessibility implies that the net migration rate rises with increasing driving time to the next motorway junction because accessibility is measured as average driving time to the corresponding traffic infrastructure.

It is interesting to see that East German cities do not suffer from a systematic disadvantage once we control for labour market performance and amenities. In fact there is some indication that East German cities tend to be on average more attractive for high-skilled labour than urban areas in West Germany.[20] Furthermore, there is robust evidence that high-skilled workers tend to prefer large urban regions. The highly significant coefficient of the city type dummy indicates that small cities are ceteris paribus marked by less net in-migration than large cities.[21] This corresponds with results by Eeckhout et al. (2014) who conclude that large cities disproportionally attract high-skilled workers. Some first nature amenities, such as the sunshine duration, and the availability of recreation area in the city positively impact on the residential choice of highly educated workers as well.

Finally we examine the explanatory power of the models and in particular the contribution of the different groups of variables to the R^2. Our models explain a considerable proportion of the disparities in urban net migration rates. The adjusted R^2 varies between 0.36 and 0.47. We also report the additive Shorrocks-Shapley decomposition of the R^2-statistic (Shorrocks 1982). This decomposition allows us to calculate the relative contributions of labour market indicators versus amenities to the explained variation of the dependent variable. The results indicate that the contribution of the amenities exceeds the impact of the labour market indication by far. However, we have to keep in mind that the group of amenity indicators is much larger than the set of labour market variables.[22] Altogether the decomposition suggests that both groups explain a significant percentage of the variation of the net migration rate.

In Table 4, we display results for different definitions of migration of high-skilled workers and the rest of the workforce. In the first column we display the basic model from Table 3 (column 1) as a reference. With models (1) to (4) we aim at providing some evidence on the importance of skill-specific labour market conditions with respect to the mobility of high-skilled workers. In model (1), all labour market variables refer to the high-skilled segment of the labour market, whereas in the columns (2) to (4) we substitute these indicators by those that comprise all skill groups. The results underline the relevance of skill-specific labour

[20] This effect is also evident when we exclude Berlin, Leipzig and Dresden from the analysis.

[21] The dummy variable differentiates between cities in large agglomerated areas and cities in urbanised regions. The average population of the first group of cities amounts to roughly 463,000 whereas the mean population of the small cities is about 168,000 inhabitants.

[22] In fact, we subsume all variables apart from the four labour market and economic indicators into the amenity group.

market conditions in contrast to aggregate indicators that do not differentiate between distinct skill levels. The latter are displayed in the lower part of the table. While the average wage seems to be an appropriate approximation for the wage level of high-skilled workers (column 4), the unemployment rate and employment growth only show a significant impact on the migration balance if we consider the skill-specific measures. Thus, applying all-encompassing indicators might give rise to incorrect inference regarding the influence of labour market conditions for the residential choice of well-educated workers. According to these estimates workers with a university degree indeed focus on information on the performance of their skill segment in urban labour markets when deciding on the city of residence.

[Table 4 around here]

In columns (5) and (6) we change the definition of a move. Whereas the first columns refer to a change of residence, column (5) displays results for changes of the workplace of high-skilled employees and column (6) summarizes estimates for moves that involve both changes of residence and workplace. It is evident that the importance of amenities dramatically declines if we restrict the analysis to migration flows that (also) involve a change of the workplace. Many amenities that significantly impact on the change of residence do not matter in the models (5) and (6), e.g. the recreation area, sunshine duration and the share of restaurant workers. In contrast, especially the impact of wages and employment growth is confirmed for migration flows which also reflect changes of the workplace. Thus, not surprisingly, the importance of labour market conditions relative to amenities increases. This is also indicated by the Shorrocks-Shapley decomposition at the bottom of Table 4. However, the explanatory power of these models is low altogether.

In column (7) we consider the mobility of the remaining workforce as a reference for the high-skilled workers. As we focus on the change of residence in the last column, we compare the results with the estimates displayed in column (1). In sum, the findings suggest that workers with a university degree do not differ that much from other employees. For most indicators the estimates of the two groups coincide with respect to sign and significance of the effects. However, there are some noteworthy exceptions. The cultural opportunity index shows no significant correlation with the net migration rate of the remaining labour force. This stands in contrast to the positive influence on the mobility of high-skilled workers, but

fit well the results from literature as described in section 2 on page 5. Moreover, the rent level does not seem to impact on the migration of the remaining workforce. Korpi et al. (2010) also detected positive effects for high income earners while for low income groups expensive housing have adverse effects on migration. But we also have results that contradict literature. Against the arguments formulated by Florida (e.g. 2004) high qualified workers are not attracted by diversity whereas the diversity index of the city has a positive impact on the migration rate of the remaining workforce. Finally, contrary to the results in Cullen and Levitt (1999) our findings do no suggest that highly-skilled workers tend to avoid cities with higher crime rates more than less educated ones. In contrast, our results indicate that highly-skilled workers and the remaining workforce similarly react to higher crime rates, confirming the results of Dalmazzo and de Blasio (2011).

If we interpret the positive effect of the rent level for the high-skilled population as indicting the capitalization of amenities, the insignificance in column (7) suggests that the corresponding amenities do not matter for the remaining group. Finally, there is no specific advantage of East German cities for this group of workers.

Notwithstanding the pooled regression models indicate that differences in residential preferences between distinct skill groups are small in Germany. This is in line with results by Hansen and Niedomysl (2009) who conclude that disparities in the migration patterns of workers with low and high educational attainment seem to be of minor importance in Sweden. Nonetheless, Niedomysl and Hansen (2010) provide some evidence that highly educated migrants put relatively more emphasis on cultural and entertainment facilities than less-educated persons.

In order to examine whether unobserved time-invariant heterogeneity adversely affects the regression results we apply fixed effects models. Table 5 summarises the corresponding results for changes of residence of high-skilled workers and the remaining workforce. In columns (2) and (4) we display robustness checks using Driscoll-Kraay standard errors which are heteroscedasticity consistent and robust to cross-sectional and temporal dependence. A comparison of the estimates with robust standard errors and those with Driscoll-Kraay standard errors points to the relevance of cross-sectional and temporal correlation. For several explanatory variables standard errors differ significantly. As the Driscoll-Kraay

estimates are more reliable the interpretation of the fixed effects models focuses on the columns (2) and (4).

The coefficient estimates for workers with a university degree in column (2) significantly differ from the corresponding results of the pooled models. These differences underline the importance of the omitted variable bias that severely affects the pooled regression results. The size, significance and even the sign of several coefficients changes if we include city fixed effects. The size of all labour market effects on migration declines. Only the impact of wages and employment growth is still significant at the 1% and 10% level respectively. All labour market and economic variables seem to suffer from an important upward bias in absolute terms in the pooled models. This also applies to some amenity indicators such as the recreation area. For the cultural opportunity index, the population density and the share of the foreign population we even observe changes of the sign. However, the corresponding effects do not significantly differ from zero. This also applies to the crime rate and the percentage of highly qualified workers. On the other hand, there are also some amenity variables that seem to show downward bias in the pooled models. In fact, the influence of the flat size, the share of restaurant workers and the cultural diversity indicator on the mobility of high-skilled workers increases in the fixed effects specification as compared to the pooled regression.

[Table 5 around here]

Turning to the estimates for the remaining workforce in column (4), we detect some notable deviations from the results for the high-skilled workers. Labour market conditions and the economic situation seem to be slightly more important for the remaining workforce as three out of four indicators show significant effects for this group of workers. However, the negative effect of the regional wage level is not in line with theoretical expectations.[23] Moreover, only for the remaining workforce we discover an important impact of disamenities as indicated by the negative coefficients of the crime rate and the population density. It is also interesting to see that only for the remaining workforce there is a positive effect of the population share of highly educated workers. This suggests that there might be some important complementarities and knowledge spillovers between skill groups that

[23] This may be explained by the fact that workers are willing to accept wage cuts when moving in order to improve job-specific amenities like flexible work schedules, promotion possibilities or improvements in strain (Schneck 2011).

attract medium- and low-skilled workers to cities with a relatively high share of high-skilled employees. The high-skilled themselves, in contrast, do not seem to significantly benefit from productivity-enhancing effects of the regional human capital endowment. On the other hand, cultural diversity only shows a significant positive association with the migration of highly educated workers.

Altogether, the fixed effects results provide more evidence that there are some important differences in residential preferences between skill groups than the pooled models. However, there are also a number of factors that influence both mobility of high-skilled as well as migration of the remaining workforce such as employment growth, the flat size and the share of restaurant workers. In particular, we do not detect systematic differences between labour market conditions and amenities in the sense that they only impact on the utility of specific skill groups. Across skill levels there is evidence that both groups of push and pull factors matter.

Finally, we examine whether the estimates of the labour market effects severely suffer from endogeneity. We focus on the labour market indicators although we are aware that the estimates of other variables might be affected by reverse causality as well. Moreover, we only deal with one endogenous variable per IV estimation because when instrumenting all endogenous variables in a single estimation we run increasingly into weak instrument problems.[24] The results of the IV estimations are summarized in Table 6. We consider both high-skilled workers and the remaining workforce, but only report the estimates of the three labour market indicators and tests concerning the quality of the instruments. However, all models include the same explanatory as the specifications in Table 5 in addition to city fixed effects. As indicated by different tests statistics at the bottom of Table 6 the applied instruments z_{it} should be valid, i.e. relevant [corr(z_{it}, $labourmarket_{kit}$) ≠ 0] and uncorrelated with the error term [corr(z_{it}, ε_{it}) = 0]. We apply the test of overidentifying restrictions to check instrument exogeneity. The results of the Hansen J-statistic suggest that we cannot reject the hypothesis that the instruments are exogenous. Moreover, the Kleibergen–Paap LM tests reject the null hypothesis at the 1% level, i.e. our instruments should be adequate for identification of the model. The F-statistics of excluded instruments indicate that the partial correlation between the instruments and the endogenous explanatory variables

[24] Corresponding results are available from the authors upon request.

should be sufficient to ensure unbiased estimates and relatively small standard errors. According to the Anderson-Rubin test we cannot reject the significance of the corresponding labour market effects at the 5% level in all models apart from the columns (2) and (6). Finally, the Cragg-Donald tests indicate that the results are not affected by weak instruments.

[Table 6 around here]

The IV estimation confirms the important role of the skill-specific wage level for the mobility of high-skilled workers in Germany. Comparing the IV estimates with the fixed effects regression in Table 5, it seems that there is no severe bias of the wage effects. There is also some indication that employment growths matters for the high-skilled in column (3). However, we have to negate a significant role of the unemployment rate for the residential choice of highly qualified individuals based on the fixed effects and IV regressions. As regards the remaining workforce, we arrive at a positive and significant impact of the wage level on the net migration rate if we instrument. But the corresponding effect is not robust. If we instrument the other labour market indicators we again get a negative association between urban wages and city migration balance that is not in line with theoretical arguments. In column (5) we instrument the unemployment rate and detect an important adverse impact that was not visible in the fixed effects regression. These findings suggest that reverse causality might lead to an important upward bias of the corresponding effect. In contrast, IV estimation does not improve the result for employment growth although the instruments are valid and exogenous according to the relevant tests.

6 Conclusions

The competitiveness of cities has received growing attention for regional development policies and planning during the last decades because urban areas are increasingly becoming centres of economic activity in the knowledge-based economies of highly developed countries (Hansen and Niedomysl 2009). Moreover, human capital is increasingly seen as a crucial resource for knowledge intensive production and, thus, for the competiveness of cities. In contrast to other factors of production high-skilled workers are highly mobile and therefore, in response to this high mobility, regions need to provide favourable living conditions in order to attract and retain high-skilled labour.

In this paper, we have investigated the push and pull factor behind migration flows of high-skilled workers for a cross section of German cities. The results of our regression analysis point to several important determinants of urban migration rates. Local labour market conditions influence the mobility decision but amenities matter too for the high-skilled. This is in line with evidence provided by Nifo and Vecchione (2013) or Dalmazzo and de Blasio (2011). Relatively high wages and the creation of new jobs attract workers with a university degree, while evidence for unemployment is less robust. Thus the findings challenge the emphasis placed on the urban quality of life when residential preferences of high skilled workers are concerned (e.g. Florida 2004). However, first and second nature amenities impact on the migration balance of high-skilled workers as well. This is, in particular, reflected by the robust effects of the sunshine duration, the flat size and the share of restaurant workers. Furthermore, there is some indication that high-skilled labour prefers urban regions which are characterized by an above average cultural diversity of the population.

According to Glaeser and Resseger (2010) bigger cities attract more skilled workers. This corresponds with the finding that large German cities ceteris paribus show stronger net in-migration of highly qualified workers than small cities. However, we detect no significant positive impact of the regional human capital on the migration balance of the high-skilled. In contrast, there is a strong positive association between the population share of high-skilled and the net migration rate of the remaining workforce that indicates that there might be some important complementarities across skill groups. Altogether, the findings suggest that the liking of highly qualified workers differs from the preferences of the rest of the workforce in some specific aspects of the decision-making. However, there are also several factors that do not show systematic differences across skill groups. Most importantly, the analysis indicates that the role of labour market conditions and amenities does not vary across skill levels. Comparable results has been offered so far only with respect to the (conform) meaning of amenities for different skill groups (Brown and Scott 2012, Carlsen and Leknes 2013 and Zheng 2014). In order to provide corresponding evidence it is, however, important to consider skill-specific labour market conditions in contrast to aggregate labour market indicators as our results suggest that workers with a university degree indeed focus on information on the performance of their skill segment in urban labour markets when deciding on the city of residence.

While there are certain differences in residential preferences between distinct skill groups, it seems to be more important to distinguish between different definitions of moves. According to our results, it is crucial to consider different definitions of labour migration, i.e. to differentiate between moves that involve a change of the residence and moves that (also) involve a change of the workplace. For the latter group, not surprisingly, the importance of labour market conditions relative to amenities increases. However, the explanatory power of these models tends to be low. Thus, a better understanding of migration that refers to both a change of residence and workplace is clearly an issue for future research.

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Tables and Figures

Table 1: Correlation analysis - net migration rates

	total, D1	total, D2	total, D3	HQ, D1	HQ, D2	HQ, D3	RW, D1	RW, D2
total, D2	0.612							
total, D3	0.571	0.278						
HQ, D1	0.632	0.388	0.364					
HQ, D2	0.452	0.561	0.215	0.711				
HQ, D3	0.413	0.206	0.728	0.484	0.298			
RW, D1	0.934	0.583	0.526	0.357	0.263	0.294		
RW, D2	0.571	0.978	0.257	0.262	0.398	0.157	0.597	
RW, D3	0.549	0.271	0.971	0.272	0.161	0.567	0.548	0.265

Notes: D1: change of residence and workplace, D2: change of workplace, D3: change of residence, total: total workforce, HQ: highly qualified workers, RW: remaining workforce.

Table 2: Summary statistics

	Mean	S.D. overall	S.D. between	S.D. within	Min	Max
Net migration rates						
net migration rate (HQ, D3)	-7.91	11.05	8.55	7.08	-56.78	50.84
net migration rate (HQ, D2)	-1.82	21.46	11.25	18.32	-103.58	153.42
net migration rate (HQ, D1)	-0.76	5.00	3.07	3.97	-20.43	28.88
net migration rate (RW, D3)	-3.71	5.05	3.46	3.70	-33.77	9.15
net migration rate (RW, D2)	-2.48	13.24	5.92	11.87	-83.36	79.00
net migration rate (RW, D1)	-0.07	1.87	1.33	1.32	-10.06	9.28
Labour market variables						
business	1.54	1.32	0.84	1.03	-7.94	6.85
employment growth (HQ)	2.20	2.87	1.94	2.13	-6.90	17.88
employment growth (RW)	0.04	1.83	0.91	1.59	-6.26	6.52
unemployment rate (HQ)	8.76	3.22	2.63	1.89	1.48	18.19
unemployment rate (RW)	12.30	3.93	3.58	1.67	4.10	26.20
wage level (HQ)	130.88	17.87	16.90	6.12	82.73	177.53
wage level (RW)	81.55	11.22	10.68	3.64	52.80	116.63
Amenities						
access airport	39.90	24.89	25.05	0	7.00	125.40
access motorway	6.54	3.19	3.22	0	0.40	14.80
access train	5.60	9.99	10.05	0	0.00	45.80
crime rate	10.49	2.65	2.49	0.93	0.67	21.59
cultural opportunity index	29.66	13.98	13.97	2.05	8.40	100.69
diversity index	86.87	8.89	8.81	1.59	51.36	96.52
dummy city type	0.42	0.49	0.50	0	0	1
dummy East	0.16	0.37	0.37	0	0	1
emissions	34.81	9.34	7.13	6.08	7.77	63.11
flat size	388.08	22.86	21.46	8.25	323.00	465.00
population density	16.67	7.31	7.34	0.43	4.62	42.82
price index	94.91	5.46	5.50	0	86.90	114.40
recreation area	5.02	2.59	2.45	0.90	1.22	15.05
rent	6.54	1.29	1.18	0.52	3.22	12.00
share highly qualified	14.60	6.28	6.09	1.67	4.57	37.17
share of foreigners	12.74	5.54	5.56	0.44	1.08	26.28
share restaurant workers	22.43	6.29	6.17	1.42	11.26	51.42

students	69.59	62.86	62.40	10.46	0.00	286.30
sun	16.61	2.05	1.08	1.75	5.42	22.70
temperature	16.68	3.72	1.71	3.32	-3.30	28.20
theatre visitors	9.77	10.85	10.64	2.11	0.49	77.30

Notes: D1: change of residence and workplace, D2: change of workplace, D3: change of residence, HQ: highly qualified workers, RW: remaining workforce.

Table 3: Results of pooled regressions I

Dependent variable	Net migration rate (HQ, D3)				
	(1)	(2)	(3)	(4)	(5)
wage level (HQ)	0.26***	0.21***	0.25***	0.34***	0.25***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
employment growth (HQ)	0.51***	0.14	0.57***	0.35**	0.46***
	(0.17)	(0.18)	(0.16)	(0.14)	(0.17)
unemployment rate (HQ)	-0.86***	-1.05***	-0.52***	-0.53***	-0.81***
	(0.15)	(0.16)	(0.14)	(0.15)	(0.16)
business	0.79***	0.77**	0.38	0.68**	0.82***
	(0.28)	(0.31)	(0.27)	(0.28)	(0.28)
share restaurant workers	0.43***	0.36***	0.34***	0.46***	0.44***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)
cultural opportunity index	0.04*	0.02	0.12***	0.06***	0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
share highly qualified	-0.51***	-0.43***	0.06	-0.63***	-0.57***
	(0.09)	(0.09)	(0.12)	(0.10)	(0.09)
share of foreigners	-0.61***	-0.66***	-0.56***	-0.18	-0.73***
	(0.13)	(0.14)	(0.12)	(0.13)	(0.13)
diversity index	0.09	0.06	0.21***	0.22***	0.06
	(0.06)	(0.06)	(0.06)	(0.07)	(0.06)
rent	0.94***	0.73**	0.25	0.24	
	(0.36)	(0.34)	(0.35)	(0.34)	
flat size	0.06***	0.04**	0.04**	0.05***	0.07***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
crime rate	-0.38*	-0.26	-0.47**	-0.46**	-0.49**
	(0.21)	(0.21)	(0.19)	(0.20)	(0.21)
population density	-0.20**	-0.13	-0.38***	-0.49***	-0.24***
	(0.09)	(0.08)	(0.08)	(0.09)	(0.09)
access motorway	0.90***	0.85***	0.68***	0.50***	0.88***
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
access airport	-0.06***	-0.06***	-0.05***	-0.06***	-0.07***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
access train	-0.01	-0.03	-0.09**	-0.01	-0.03
	(0.04)	(0.03)	(0.04)	(0.03)	(0.03)
dummy East	7.96***	3.68*	2.50	11.21***	8.30***
	(2.01)	(1.99)	(1.93)	(2.10)	(2.04)
dummy city type	-4.14***	-3.70***	-4.35***	-4.08***	-3.70***
	(0.95)	(0.95)	(0.91)	(0.95)	(0.90)
sun	0.54***	0.67***	0.46***	0.44**	0.43**
	(0.18)	(0.19)	(0.17)	(0.17)	(0.18)
recreation area	0.59***	0.45**	0.37*	0.62***	0.79***
	(0.22)	(0.22)	(0.19)	(0.21)	(0.21)
temperature	-0.01	-0.07	0.01	-0.04	0.01
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
emissions		-0.14***			

		(0.04)			
students			-0.08***		
			(0.01)		
theatre visitors				0.21***	
				(0.03)	
price index					0.45***
					(0.12)
constant	-74.87***	-51.50***	-72.07***	-89.58***	-108.13***
	(9.24)	(9.19)	(9.40)	(9.83)	(13.35)
observations	712	596	712	614	731
R^2	0.42	0.39	0.49	0.49	0.43
adjusted R^2	0.40	0.36	0.47	0.47	0.41
R^2 - labour market[1]	34.46%	34.52%	24.68%	32.16%	32.81%
R^2 - amenities	65.54%	65.48%	75.32%	67.84%	67.19%
F-statistic	22.80	15.98	24.05	22.97	24.51

Notes: robust standard errors in parenthesis; * significance at the 0.1 level, ** significance at the 0.05 level, *** significance at the 0.01 level, D3: change of residence, HQ: highly qualified workers, [1]: wage level, unemployment rate, employment growth, business.

Table 4: Results of pooled regressions II

Dependent variable	Net migration rate						
	HQ, D3				HQ, D2	HQ, D1	RW, D3
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
wage level[1]	0.26***	0.34***	0.27***		0.43***	0.12***	
	(0.04)	(0.04)	(0.04)		(0.13)	(0.02)	
employment growth[1]	0.51***	0.68***		0.53***	1.00**	0.34***	
	(0.17)	(0.19)		(0.17)	(0.39)	(0.09)	
unemployment rate[1]	-0.86***		-0.91***	-1.04***	-0.31	-0.14*	
	(0.15)		(0.16)	(0.16)	(0.32)	(0.07)	
business	0.79***	0.46	0.77***	1.20***	-0.66	-0.09	1.05***
	(0.28)	(0.29)	(0.28)	(0.29)	(0.71)	(0.16)	(0.14)
share restaurant workers	0.43***	0.45***	0.42***	0.42***	-0.15	-0.02	0.17***
	(0.07)	(0.07)	(0.08)	(0.08)	(0.19)	(0.04)	(0.04)
cultural opportunity index	0.04*	0.05**	0.04*	0.01	0.08	0.03**	-0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.06)	(0.01)	(0.01)
share highly qualified	-0.51***	-0.49***	-0.49***	-0.59***	-0.43**	-0.23***	-0.26***
	(0.09)	(0.09)	(0.09)	(0.10)	(0.21)	(0.05)	(0.04)
share foreigners	-0.61***	-0.43***	-0.61***	-0.66***	-0.48	-0.08	-0.14***
	(0.13)	(0.13)	(0.13)	(0.14)	(0.32)	(0.07)	(0.05)
diversity index	0.09	0.10	0.08	0.10	0.07	0.05	0.05**
	(0.06)	(0.07)	(0.06)	(0.06)	(0.17)	(0.04)	(0.02)
rent	0.94***	1.04***	0.94***	1.07***	0.25	0.26	-0.03
	(0.36)	(0.38)	(0.36)	(0.37)	(0.80)	(0.19)	(0.16)
flat size	0.06***	0.06***	0.06***	0.05***	-0.01	0.00	0.02**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.01)	(0.01)
crime rate	-0.38*	-0.71***	-0.37*	-0.53**	0.65	0.17*	-0.73***
	(0.21)	(0.20)	(0.21)	(0.21)	(0.40)	(0.09)	(0.09)
population density	-0.20**	-0.27***	-0.22**	-0.17*	-0.02	0.03	-0.14***
	(0.09)	(0.09)	(0.09)	(0.09)	(0.16)	(0.04)	(0.04)
access motorway	0.90***	0.86***	0.95***	0.84***	0.07	0.04	0.28***
	(0.11)	(0.11)	(0.11)	(0.11)	(0.26)	(0.06)	(0.05)
access airport	-0.06***	-0.07***	-0.06***	-0.07***	-0.00	-0.00	-0.02**

	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.01)	(0.01)
access train	-0.01	-0.00	-0.02	-0.00	-0.01	0.01	-0.02
	(0.04)	(0.04)	(0.04)	(0.04)	(0.08)	(0.02)	(0.02)
dummy East	7.96***	11.43***	6.67***	5.76***	10.09**	4.04***	0.49
	(2.01)	(2.09)	(1.92)	(2.08)	(4.23)	(1.01)	(0.89)
dummy city type	-4.14***	-4.22***	-3.79***	-4.17***	-1.11	-0.60	-1.43***
	(0.95)	(0.98)	(0.95)	(0.99)	(2.17)	(0.50)	(0.45)
sun	0.54***	0.34*	0.51***	0.69***	-0.22	0.04	0.16**
	(0.18)	(0.18)	(0.18)	(0.19)	(0.39)	(0.08)	(0.08)
recreation area	0.59***	0.58***	0.64***	0.68***	0.24	-0.04	0.55***
	(0.22)	(0.22)	(0.22)	(0.22)	(0.33)	(0.09)	(0.09)
temperature	-0.01	-0.00	0.02	-0.01	0.15	0.06	-0.01
	(0.09)	(0.09)	(0.09)	(0.10)	(0.19)	(0.04)	(0.04)
unemployment rate[2]		-0.07					-0.18***
		(0.16)					(0.06)
employment growth[2]			0.28				0.68***
			(0.27)				(0.10)
wage level[2]				0.27***			0.07***
				(0.07)			(0.03)
constant	-74.87***	-89.53***	-74.86***	-60.86***	-57.31**	-22.00***	-14.55***
	(9.24)	(10.06)	(9.43)	(9.02)	(22.53)	(4.82)	(4.24)
observations	712	712	712	712	712	712	712
R^2	0.42	0.39	0.41	0.40	0.09	0.19	0.41
adjusted R^2	0.40	0.37	0.39	0.38	0.07	0.16	0.39
R^2 - labour market[3]	34.46%	25.63%	34.11%	33.45%	62.50%	56.98%	36.55%
R^2 - amenities	65.54%	74.37%	65.89%	66.55%	37.50%	43.02%	63.45%
F-statistic	22.80	22.52	22.39	20.74	2.63	7.05	14.52

Notes: robust standard errors in parenthesis; * significance at the 0.1 level, ** significance at the 0.05 level, *** significance at the 0.01 level; D1: change of residence and workplace, D2: change of workplace, D3: change of residence, HQ: highly qualified workers, RW: remaining workforce, [1]: highly qualified workers, [2]: total workforce, [3]: wage level, unemployment rate, employment growth, business.

Table 5: Results of fixed effects estimation

Dependent variable	Net migration rate, D3			
	Highly qualified workers		Remaining workforce	
	(1)	(2)	(3)	(4)
wage level[1]	0.29**	0.29***	-0.36***	-0.36***
	(0.14)	(0.07)	(0.13)	(0.06)
employment growth[1]	0.22	0.22*	0.34***	0.34***
	(0.19)	(0.12)	(0.10)	(0.07)
unemployment rate[1]	-0.15	-0.15	0.01	0.01
	(0.26)	(0.19)	(0.11)	(0.18)
business	-0.04	-0.04	0.24*	0.24*
	(0.35)	(0.31)	(0.13)	(0.13)
share restaurant workers	0.51***	0.51***	0.25	0.25***
	(0.17)	(0.09)	(0.17)	(0.06)
cultural opportunity index	-0.11	-0.11	0.21**	0.21***
	(0.17)	(0.07)	(0.08)	(0.05)
share highly qualified	-0.22	-0.22	0.74***	0.74***
	(0.41)	(0.28)	(0.23)	(0.13)

share foreigners	0.73	0.73	0.69	0.69**
	(0.89)	(0.93)	(0.44)	(0.33)
diversity index	0.42	0.42***	-0.02	-0.02
	(0.27)	(0.15)	(0.12)	(0.06)
rent	0.47	0.47	0.03	0.03
	(0.68)	(0.64)	(0.41)	(0.21)
flat size	0.16**	0.16**	0.14***	0.14***
	(0.06)	(0.07)	(0.05)	(0.03)
crime rate	-0.17	-0.17	-0.29	-0.29***
	(0.26)	(0.27)	(0.18)	(0.09)
population density	0.20	0.20	-0.58	-0.58***
	(0.64)	(0.57)	(0.44)	(0.15)
sun	0.27**	0.27***	0.13**	0.13*
	(0.12)	(0.06)	(0.06)	(0.07)
recreation area	-0.17	-0.17	0.82***	0.82***
	(0.24)	(0.24)	(0.16)	(0.15)
temperature	0.05	0.05	-0.05*	-0.05
	(0.06)	(0.07)	(0.03)	(0.03)
observations	712	712	712	712
R^2 - within	0.27	0.27	0.40	0.39
R^2 - between	0.03		0.00	
R^2 - overall	0.06		0.00	
F - statistic	9.55	57.90	11.28	42.78

Notes: * significance at the 0.1 level, ** significance at the 0.05 level, *** significance at the 0.01 level; columns (1) and (3): robust standard errors in parenthesis, columns (2) and (4): Driscoll-Kraay standard errors in parenthesis, D3: change of residence, [1]: columns (1) and (2): highly qualified workers, columns (3) and (4): total workforce.

Table 6: Results of IV regressions

Dependent variable	Net migration rate, D3					
	Highly qualified workers			Remaining workforce		
	(1)	(2)	(3)	(4)	(5)	(6)
wage level[1]	0.55***	0.31***	0.27***	0.68***	-0.32***	-0.36***
	(0.19)	(0.10)	(0.10)	(0.31)	(0.09)	(0.09)
employment growth[1]	0.21	0.14	1.44***	0.44***	-0.06	0.20
	(0.15)	(0.18)	(0.49)	(0.12)	(0.13)	(0.19)
unemployment rate[1]	-0.25	-0.44	0.42	0.07	-0.68***	-0.06
	(0.20)	(0.54)	(0.27)	(0.08)	(0.18)	(0.12)
observations	712	712	712	534	706	712
F-statistic of excluded IV						
wage level	81.36			22.63		
unemployment rate		36.15			97.90	
employment growth			35.41			121.79
Kleibergen-Paap LM test (p-value)	0.00	0.00	0.00	0.00	0.00	0.00
Hansen J-statistic (p-value)	0.61	0.28	0.75	0.69	0.10	0.48
Anderson-Rubin test (p-value)	0.01	0.48	0.01	0.04	0.00	0.40
Cragg-Donald test (F-statistic)	159.83	42.90	42.77	28.76	78.16	151.66

Notes: robust standard errors in parenthesis. * significance at the 0.1 level, ** significance at the 0.05 level, *** significance at the 0.01 level. The critical values for the Cragg-Donald statistic are 19.93 for a maximum size distortion of 10% of the IV estimator relative to the OLS estimator and 11.59 for a maximum size distortion of 15%. The significance level is 5%. We rely on critical values for the case of one endogenous regressor and two instruments (see

Stock and Yogo 2005, Table 2). The critical values for a maximum bias of x% only apply when three instruments are used and are as follows: 13.91 for a maximum bias of 5% and 9.08 for a maximum bias of 10%. Again, the significance level is 5% and we rely on critical values for the case of one endogenous regressor (see Stock and Yogo 2005, Table 1). Each regression uses time lags (5 years) of the specific labour market variable under consideration as instrumentation. Apart from this, columns (1)-(6) differ with respect to instrumentation and variables being instrumented. In columns (1), (2) and (4) the share of highly qualified workers (lagged by 6 years) is used as an additional instrument. In columns (3) and (6) we use the shift share instrument (lagged by 5 years) and in column (5) the unemployment rate of the remaining workforce is instrumented by both the shift share instrument and the share of older workers. [1]: Columns (1)-(3): highly qualified workers, columns (4)-(6): total workforce, D3: change of residence.

Appendix

Table A.1: Variable definition and data sources

Variable	Definition	Source	Period
net migration rate	Migration balance divided by corresponding employment, in ‰, definition 1: change of residence and workplace, definition 2: change of workplace, definition 3: change of residence	Employee history of the Institute for Employment Research (IAB)	2000-2010
	Labour market variables		
business	Number of business registration minus business deregistration per 1,000 inhabitants	"Regionaldatenbank Deutschland" of the Federal Statistical Office	1999-2009
employment growth	Average growth rate of employment subject to social security in the preceding three years, in %	Employment statistics of the Federal Employment Agency (FEA)	1995-2009
unemployment rate[2]	Number of unemployed persons divided by the sum of employed and unemployed persons, in %	Unemployment statistics of the Federal Employment Agency (FEA)	1995-2009
wage level[1]	40% percentile of the distribution of daily wages, in €	Employee history of the Institute for Employment Research (IAB)	1995-2009
	Amenities		
access airport	Average driving time to the next international airport, in minutes	"INKAR database - indicators and maps on spatial development" of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR)	2007
access motorway	Average driving time to the next motorway junction, in minutes	"INKAR database - indicators and maps on spatial development" of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR)	2007
access train	Average driving time to the next fast train station, in minutes	"INKAR database - indicators and maps on spatial development" of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR)	2007
crime rate	Number of criminal offenses per 100,000 inhabitants	Crime statistics of Germany`s Federal Criminal Police Office	1999-2009

cultural opportunity index	Share of working population that is employed in cultural and recreational activities, per 1,000 employees, defined by NACE codes: 553 (restaurants), 554 (bars), 921 (activities in the field of film and video), 922 (radio and television), 923 (entertainment), 925 (libraries, public archives, museums, and other cultural activities), and 926 (sports) – see Boschma and Fritsch (2009)	Employment statistics of the Federal Employment Agency (FEA)	1999-2009
diversity index	Inverse Herfindahl index of concentration across groups multiplied by 100: DIV = (1-$\sum_{k=1}^{K} s_k^2$)*100, where s_k is the share of employees with nationality k among all employees (without Germans)	Employment statistics of the Federal Employment Agency (FEA)	1999-2009
emissions	Emissions of nitrogen dioxide (NO_2), in µg/m³, pollution is measured as the average amount of emissions of all official measuring stations within a perimeter of 20 km (orthodromic distance).	"Umweltbundesamt", own calculations	2001-2009
flat size	Average flat size per inhabitant multiplied by 10, in square metres	"INKAR database - indicators and maps on spatial development" of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR)	1999-2009
population density	Population per square metre, in 1,000 inhabitants	"Regionaldatenbank Deutschland" of the Federal Statistical Office	1999-2009
price index	Average regional price index, Bonn = 100	Federal Institute for Research on Building, Urban Affairs and Spatial development (BBSR)	2005-2009 (mean)
recreation area	Recreation area (urban green space, parks, allotment gardens, sport fields, campsites) divided by total area, in %	"Regionaldatenbank Deutschland" of the Federal Statistical Office	1999-2009
rent	Monthly basic rent, in € per square metre	"RDM-Immobilienpreisspiegel"	1999-2009
share highly qualified	Number of highly qualified workers (university degree(college of higher education degree) at place of residence divided by the total number of workers	Employment statistics of the Federal Employment Agency (FEA)	1999-2009

	(at place of residence)		
share of foreigners	Number of foreigners divided by total population, in %	"Regionaldatenbank Deutschland" of the Federal Statistical Office	1999-2009
share restaurant workers	Share of working population that is employed in restaurants, per 1,000 employees, defined by KldB 1988 (classification of occupations) codes: 912 (waiters) and 411 (cooks)	Employment statistics of the Federal Employment Agency (FEA)	1999-2009
students	Number of students per 1,000 inhabitants	"INKAR database - indicators and maps on spatial development" of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR)	1999-2009
sun	Sunshine duration, in 1,000 hours	"Deutscher Wetterdienst (DWD)", own calculations	1999-2009
temperature	Difference between July and January temperature, in degree Celsius	"Deutscher Wetterdienst (DWD)", own calculations	1999-2009
theatre visitors[3]	Number of (state) theatre visitors per 10 inhabitants	"Theaterstatistik, Deutscher Bühnenverein"	1999-2009
	Instruments (apart from lags of potentially endogenous variables)		
share of older workers	Skill-specific share of population aged 45-59	Employment statistics of the Federal Employment Agency (FEA)	1994-2004
shift share instrument	Weighted average of nationwide employment growth by 86 occupation groups (skill-specific), the weights correspond with the city-specific employment share of each occupation group	Employment statistics of the Federal Employment Agency (FEA)	1995-2005

Note: [1]: In 15 (of 759) cases, the wage level of the highly qualified workers is censored from above. Since this is a relatively small number of observations it may not bias our estimation results. In order to account for this problem, all estimations are repeated without these observations. The results are similar to those presented in section 5 and therefore not presented in detail. [2]: Hence, this rate does not match the official unemployment rate by the Federal Employment Agency (FEA). [3]: We are aware that a number of theatres are not included in the theatre statistics by the "Deutsche Bühnenverein". But since this is the only official source in Germany that systematically asks theatres for their yearly visitors, we use this variable in an additional model.

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