IAAEG

Institut für Arbeitsrecht und Arbeitsbeziehungen in der Europäischen Gemeinschaft

Discussion Paper Series No. 01/2011

Job Matching Efficiency in Skilled Regions – Evidence on the Microeconomic Foundations of Human Capital Externalities

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Job Matching Efficiency in Skilled Regions - Evidence on the Microeconomic Foundations of Human Capital Externalities

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Abstract

Inspired by the literature on the role of local career networks for the quality of labor market matches we investigate whether human capital externalities arise from a higher job matching efficiency in skilled regions. Using two samples of highly qualified workers in Germany we find that an increase in the regional share of highly qualified workers by one standard deviation is associated with between-job wage growth of about three percent and an increase in the annual probability of a job change of up to four percent. Wage gains are incurred only by workers changing jobs within industries. Consistently, workers in skilled regions are about fifty percent more likely to change jobs within rather than between industries. Taken together, these findings suggest that human capital externalities partly arise because workers in skilled regions have better access to labor market information, which allows them to capitalize on their industry-specific knowledge when changing jobs.

Keywords: Human Capital Externalities, Job Matching
JEL Categories: D62, J24, J31, R11

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I. Introduction – The Microeconomics of Human Capital Externalities

> *"It is now time to [...] attempt to understand precisely how human capital externalities percolate. [...] Most mechanisms generating local increasing returns to scale can be enriched to take human capital into account and generate external effects of human capital".*
>
> Duranton (2006: 35)

The idea that aggregate human capital matters for productivity and growth, which has gained prominence with the seminal contribution by Lucas (1988), has over time been established as one of the empirical regularities in economics. While macroeconomic studies show that economic growth increases with the national average level of education, more recent investigations on the matter have predominantly come from urban and regional economics. Empirical studies by Rauch (1993), Moretti (2004b), and Rosenthal/Strange (2008) provide robust evidence that aggregate regional education positively influences individual productivity and wages.[1]

External effects from aggregate education are usually assigned to spillovers of technological knowledge. In line with the notion that "the mysteries of the trade become no mysteries but are, as it were, in the air" (Marshall 1890: 271), a number of microeconomic papers have modeled the intensity of knowledge exchange as a function of local human capital endowments (Jovanovic/Rob 1989, Jovanovic/Nyarko 1995, Black/Henderson 1999). Based on this idea, numerous empirical studies have investigated the importance of local education levels for regional innovation and growth (see Audretsch/Feldman 2004 for a survey of this literature). Without denying the importance of spillovers of technical knowledge as a source of human capital externalities, Duranton (2006) emphasizes, however, that social returns to education are likely to arise from a more complex set of microeconomic mechanisms and points to the literature on agglomeration economies as a source of inspiration.

Since Duranton/Puga (2004), the microeconomic mechanisms behind productivity enhancing effects from agglomeration are usually categorized along the lines of sharing, matching, and learning. Based on this taxonomy a number of studies have aimed to disentangle the sources of agglomeration economies as determinants of regional wages (see, e.g., Glaeser/Maré 2001, Yankow 2006, Wheeler 2006). In contrast, no such attempt has so far been made with respect to the microeconomic foundations of human capital externalities.[2]

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[1] The relationship between aggregate human capital and employment growth has been investigated among others by Simon/Nardinelli (2002) and Glaeser/Shapiro (2003); see Davies (2002) and Moretti (2004a) for a survey of the empirical literature on human capital externalities.

[2] See Heuermann/Halfdanarson/Südekum (2010) for a comparison of the empirical literatures on the urban wage premium and on human capital externalities.

Recognizing the lack of research on the microeconomic foundations of human capital externalities this study investigates the role of a higher matching efficiency in skilled regions as a microeconomic source of human capital externalities. Closely related to the literature on knowledge spillovers, which argues that information about products and process of production is transmitted more easily in skilled regions, the idea of matching externalities in skilled regions is that higher aggregate levels of education enhance the flow of information on job and career opportunities and thereby improve the quality of labor market matches in human capital rich regions. This notion is intimately linked to the literature on career networks which, starting with Fischer (1982), has emphasized the importance of individual education for the size of social networks and, hence, for access to informal information. This literature consistently finds that "the more educated people are, the larger their personal network" (Grossetti 2007: 397), implying that the accessibility of labor market information not only depends on a worker's own human capital but also on the range of direct and indirect contacts within his local network and, hence, on the local aggregate level of education.

The availability of information on job and career opportunities can in turn be expected to influence the efficiency of job matches within local labor markets (Jovanovic 1979), which finds its expression in the job change behavior of workers and in the size of wage gains incurred by job changers (Bartel/Borjas 1981, Topel/Ward 1992). As argued by Johnson (1978), the availability of labor market information reduces the cost of job search and makes workers more likely to shop between jobs, especially early in their career. At the same time, knowledge about efficient job matches allows workers to incur larger wage gains when changing jobs (Bartel 1980, Mincer/Jovanovic 1981). Based on these insights this study aims to shed light on the existence of matching externalities in skilled regions by examining whether workers in human capital rich regions (a) incur larger wage gains when changing jobs and (b) display a higher probability of changing jobs than workers in less skilled regions.

Our findings suggest that a higher matching efficiency in skilled regions is of importance as a microeconomic source of human capital externalities. An increase in the regional share of highly qualified workers by one standard deviation is associated with between-job wage growth of about three percent and with an increase in the annual probability of a job change of up to four percent. Differentiating these results by job changes occurring within and between industries, we find that wage gains are incurred only by workers changing jobs within rather than between industries. Consistently, workers in the upper quintile of skilled regions are about fifty percent more likely to change jobs within an industry compared to workers in the lowest

quintile of regions. These findings suggest that workers in human capital rich regions obtain information on career options more easily and thereby are able to capitalize on their industry-specific human capital when changing jobs.

II. Aggregate Local Education and Job Matching: Literature Review and Econometric Approach

II.1. Aggregate Local Education and Job Matching: Literature Review

The insight that local career networks matter for the incidence of job changes and for the quality of job matches goes back to the influential contribution by Granovetter (1974), who shows that more than fifty percent of job changers have found their jobs through personal contacts. In general, personal networks reduce information gaps by providing informal information to workers and firms about unobservable characteristics of the other party (Montgomery 1991). The intuition that career networks improve the quality of job matches has inspired a voluminous empirical literature in economics and sociology, which is surveyed in Ioannides/Loury (2004).

The accessibility of information on job opportunities increases with the size of career networks (Calvo-Armegnol/Jackson 2004, 2007), because information is transmitted most efficiently in networks consisting of a large number of 'weak' ties (Boorman 1975, Granovetter 1983, Podolny/Baron 1997). Empirical studies support the idea that larger career networks increase matching efficiency by transmitting labor market information more effectively. Investigating the structure of informal networks of Mexican immigrants, Munshi (2003) shows that workers in exogenously larger networks earn significantly higher wages. Similarly, Datcher (1983) and Simon/Warner (1992) show that a larger number of informal contacts allow workers to acquire information about job and employer characteristics before taking up a job.

Studies from sociology (e.g., Fischer 1982, Grossetti 2007) and psychology (e.g., Ajrouch/Blandon/Antonucci 2005) provide evidence that the size of personal networks increases significantly with individual education, i.e., higher levels of individual education are associated with larger non-kin networks among men and women. Since the amount of information an individual has access to through second or third order ties increases with the level of education of other members in the network, the size and range of career networks can be expected to increase with the average level of education within a network. Accordingly, a number of theoretical models in economics have expressed the speed and the range of information diffusion as a function of local education levels (see, e.g., Jovanovic/Rob 1989).

Effective career networks are characterized by a pronounced local dimension. Models from information science (Watts/Strogatz 1998, Cowan/Jonard 2004), epidemiology (Jeger et al. 2007), and economics (Acemoglu/Bimpikis/Ozdaglar 2010) show that information is transmitted most efficiently in networks exhibiting distinct small world properties, meaning that about ninety percent of contacts are regionalized, while the rest are of a long-distance nature. These theoretical insights are confirmed by a number of empirical studies on the geographical scope of career networks. Controlling for reverse causality and sorting effects, Bayer/Ross/Topa (2008) show that individual career perspectives and wages are shaped through social interactions between workers within the same block of residence. Their study is complemented by a broad literature showing that face-to-face communication and peer effects within local environments enhance the diffusion of knowledge on job perspectives (Cutler/Glaeser 1997), entrepreneurial opportunities (Acs/Armington 2004), and innovation (Jaffe/Trajtenberg/Henderson 1993).[3] The local nature of career networks is underpinned by numerous case studies. Casper/Murray (2005) provide evidence on the regionalization of information flows by showing that career paths of highly qualified workers within biotechnology clusters in Cambridge, UK, and in Munich, Germany, are shaped through participation in strongly localized career networks. In the same vein, Combes/Linnemer/Visser (2008) show that personal networks, which are of prime importance for candidates to be successful in the centralized hiring procedure of economics professors in France, are of a strong local nature, i.e., are usually located within economics departments.

Taken together, the existing literature suggests that labor market information can be regarded as a local public good which increases in supply with the density of localized social networks, i.e., the amount of labor market information a workers has access to rises not only with his own level of education, but also with the local aggregate level of human capital. Based on this consideration, Helsley/Strange (1990) argue that the availability of labor market information increases with the degree of agglomeration, leading to a higher matching efficiency in cities. A number of empirical studies in the literature on agglomeration externalities have thereafter addressed the question whether higher urban wages arise from better matching opportunities in cities.

These studies have usually resorted to the identification strategy by Topel/Ward (1992), i.e., they have examined whether wage gains of job changers and the probability of workers to change jobs increase with the local level of agglomeration. Within this literature, Glaeser/Maré (2001) and Wheeler (2006) show that wage gains of job changers are larger in cities than in the countryside. Accordingly, Bleakley/Lin (2007) and Finney/Kohlhase (2007) find that workers in cities change jobs more often

[3] See Brock and Durlauf (2001) for a comprehensive survey of the literature on social interaction.

than workers in rural areas. Similar results are obtained by Freedman (2008) who shows that the probability of intra-industry compared to inter-industry job changes is significantly higher in agglomerated areas.

While these results suggest that the efficiency of job matches rises with the regional degree of agglomeration, one may contest that improved matching opportunities are caused by urban density alone. In fact, the close correlation between agglomeration and aggregate education levels leaves room for human capital externalities as an explanation for a higher quality of job matches in cities. Since workers and firms usually possess only imperfect information about the respective other, the availability of knowledge about efficient matches is likely to be as important for matching efficiency as the availability of jobs and workers.

Based on this consideration we resort to the identification approach employed in the literature on agglomeration externalities in order to analyze whether matching efficiency in local labor markets rises with the local aggregate level of education.

II.2. Identifying Matching Externalities: Two Approaches

To investigate whether wage gains of job changers are influenced by the local level of human capital, we first estimate Mincerian wage equations which are augmented by indicators for job change and regional human capital endowments, as well as by interactions thereof.

$$w_{i,t} = \sum_{k=1}^{K} X_{k,i,t}\beta_k + \sum_{m=1}^{M} Z_{m,r,t}\gamma_m + \delta_1 J_{i,t} + \delta_2 HC_{r,t} + \delta_3 J_{i,t} \times HC_{r,t} + \phi_r + \phi_t + \phi_s + \varepsilon_{i,t} \quad (1)$$

More specifically, we estimate the wage w of individual i at time t as a function of k individual characteristics $X_{k,i,t}$, a number of m regional characteristics $Z_{m,r,t}$, the incidence of a job change $J_{i,t}$ of individual i at time t, the share of highly qualified workers $HC_{r,t}$ in region r at time t, as well as the interaction between the latter two. In addition, we include region (ϕ_r), time (ϕ_t), and industry (ϕ_s) fixed effects in order to control for wage effects from macroeconomic and region-specific shocks and to rule out the possibility that wage effects arise because job changers in skilled regions systematically self-select into higher paying industries. The prime parameter of interest is δ_3, which measures the extent to which wage gains incurred by job changers depend on the regional aggregate level of education.

Estimating Probit equations we then examine whether the probability of a worker to change jobs increases with the local aggregate level of education:

$$\Delta J_{i,t} = \sum_{h=1}^{H} X_{h,i,t}\theta_k + \sum_{n=1}^{N} Z_{n,r,t}\vartheta_m + \tau HC_{r,t} + \phi_r + \phi_t + \varepsilon_{i,t} \quad (2)$$

The incidence of a job change $\Delta J_{i,r,t}$ of individual *i* at time *t* is expressed as a function of *h* individual and *n* regional characteristics $X_{h,i,t}$ and $Z_{n,r,t}$, as well as of the share of highly qualified workers $HC_{r,t}$ in region *r* at time *t*. In addition, we control for region and time fixed effects. The main parameter of interest is τ, which indicates whether regional human capital levels influence the probability of a job change.

We focus on highly qualified workers in order to avoid an overestimation of matching effects from aggregate education. Ciccone/Peri (2006) have shown that the imperfect substitutability between skilled and unskilled workers threatens a correct identification of human capital externalities, because due to supply and demand effects a rise in regional education levels depresses wages of skilled workers and increases those of unskilled workers. Hence, with an overall increasing supply of skilled workers and a large share of unskilled workers human capital externalities might be overestimated when using the full sample. Since the primary objective here is to provide first evidence on the role of matching externalities as a microeconomic source of human capital externalities, we focus on highly qualified workers alone, accepting that the size of matching externalities might be underestimated.

We employ the regional share of highly qualified workers as a measure of regional human capital for two reasons: first, we follow Krueger/Lindahl (1999) in their argument that productivity effects from aggregate human capital are more likely to be rooted in the regional share of highly qualified workers than in the overall average level of education. Second, for reasons outlined above we restrict our sample to highly qualified workers. As Kremer (1997) shows that individuals sort into networks which are homogenous with respect to social status, education, and abilities, the presence of other highly qualified workers is likely to be more relevant for career opportunities of highly qualified workers than the average regional level of education per se.

We define labor market regions along the lines of the 75 '*Raumordnungsregionen*' defined by the Federal Office for Building and Regional Planning, which are equal to NUTSII regions (BfLR 1996). While these regions are not explicitly defined so as to reflect workers' commuting behavior, they do, by principle of construction, always cover a core city and its surrounding periphery (see Kosfeld/Eckey/Türck 2006).

We restrict the analysis to workers who change jobs without changing regions. Focusing on intra-region job changers allows for identifying matching effects from regional human capital more clearly by avoiding bias from several confounding factors. The biggest threat to a proper identification of human capital externalities stems from the fact that regional human capital exhibits both amenity and productivity effects (Roback 1982). Thus, while the regional level of human capital increases a worker's productivity, it also constitutes an amenity inasmuch as workers

might be willing to accept wage reductions in exchange for living and working in a more educated environment. Reducing the sample to workers changing jobs within regions ensures that wage reducing amenity effects do not affect wage growth on the incidence of a job change because pre-job change wages are already amenity adjusted. In addition, workers moving regions tend to be highly self-selected with respect to unobservable but productivity relevant characteristics such as motivation or ambition. Routinely, this problem is addressed by including worker fixed effects. Unfortunately, the use of worker fixed effects is impeded by the small number of job changes in the data. As a result of the high collinearity between fixed effects and the job change dummy the estimators on job change effects and their interactions with aggregate human capital are not identified. In the absence of workers fixed effects, restricting the sample to workers changing jobs within regions can be regarded as a second-best option in order to reduce unobserved heterogeneity between workers.[4]

Restricting the sample to within-region job changers allows for explicitly investigating the importance of regional aggregate education for the efficiency of job matches within regional labor markets. However, as career networks are likely to be of different importance for intra-regional and inter-regional job changers, the results might be to a limited extent transferable to workers changing jobs between regions. In order to shed light on the spatial scope of career networks we also estimate all regressions for the full sample so as to see whether matching effects arise in the same manner for workers changing jobs between regions.

II.3. Human Capital Externalities and Matching: Data and Descriptives

The empirical analysis is based on the IABS data set provided by the Institute for Labor and Employment Research in Nuremberg. The IABS is a two percent sample of all workers in Germany holding a job subject to social security contribution and contains longitudinal information on workers' employment histories, as well as on further individual characteristics (see Drews 2007 for a description of the data). The definition of worker status along the lines of social security contributions excludes self-employed workers and public servants. From this spell data we construct a panel data set encompassing all observations made on the 30th of June of each year. This annualized panel data set contains more than 18 million observations for Western Germany between 1975 and 2004.

[4] Another problem we eliminate when restricting the sample to workers changing jobs within regions is that workers moving regions are sometimes compensated for their moving efforts by their future employer. Since these one-time payments cannot be identified in the data, ruling out the occurrence of moves across regions reduces the threat from upward bias in the estimations on matching effects.

In addition to its panel structure, the main merit of the data set is that it is very reliable because these data provide the source for calculating social benefits entitlements, and employers are therefore obliged to submit them to the best of their knowledge. The drawback of data being generated from the employment register is that wages are top coded at the threshold of maximum social security payments.[5] We have therefore imputed wages above this threshold by predicting them from a full set of individual characteristics (see Gartner 2005). Throughout the paper wages are defined as gross daily wages, which are inflation adjusted to the 2004 Euro level.

The education variable is a six-stage indicator containing information on a worker's highest degree of formal education. We have corrected for inconsistent coding by using an improved variable provided by Fitzenberger/Osikominu/Völter (2006) and Drews (2006). Part-time employees, apprentices, and trainees are excluded from the data, which leaves 12 million observations on about one million full time employees in Western Germany between 1975 and 2004. We further restrict the data to contain only highly qualified workers, defined as workers holding a degree from a university or a technical college, which reduces the number of observations to 873,109. From these data we construct two subsamples.

Close to the approach by Jacobson/LaLonde/Sullivan (1993), the first subsample contains a balanced panel of workers, encompassing all highly qualified employees with a full set of observations between 1999 and 2004, i.e., workers with a total of six observations in this period. Since these workers are required to stay within one region, i.e., to neither change employers nor move houses between regions, all workers changing jobs or regions, except those changing jobs within regions in 2000, are excluded from the sample. This leaves 110,454 observations on 18,409 workers, out of which 1,143, i.e., 6.21 percent, change firms in 2000 without changing regions. We define a dummy variable which equals 1 (0) if a worker belongs to the group of job changers (job stayers). Earmarking the group of job changers over the whole period of investigation, rather than just for the year 2000, allows controlling for systematic and persistent unobservable differences between job changers and job stayers. Focusing on job changes occurring in 2000 eliminates bias from changing macroeconomic environments, or systematic changes of motives for job changes over time, e.g., due to business cycles.

While providing insight into the average size of matching effects from aggregate human capital, the drawback of using a balanced panel containing just one job change is that it does not allow for examining whether such matching effects change

[5] The ten percent of workers earning wages above this threshold, which increases annually approximately in line with overall wage growth, are free to choose to either pay the maximum amount of social security payments, or to leave the public system and insure privately.

with the number of prior job changes. In order to examine this issue and to corroborate the results obtained from the first sample we construct a second sample which allows for tracking workers from their career start onwards. This sample contains only workers who show up for the first time in the data after 1975 (in order to avoid left-censoring), are below the age of thirty when observed for the first time, and who have a full set of observations until they either leave the local labor market or until the sample ends in 2004.[5] This sample contains 155,680 observations on 23,187 workers, i.e., workers are observed on average for a period of 6.7 consecutive years. Since workers can change jobs several times, we observe 10,522 job changes (6,814 first, 2,417 second, 841 third, and 450 job changes of higher ranks) made by 6,814 persons. Workers change jobs on average .45 times during the period of observation. Similar to workers in the first sample, the annual probability for a worker to change jobs is 6.7 percent.

Table I contains descriptive statistics for both samples. Since the first sample is made up of workers of all ages while the second sample consists of workers at the start of their working life, workers in the first sample are on average older, earn higher wages and exhibit more years of experience and tenure. In addition, the regional share of highly qualified workers is two percentage points higher in the first sample, reflecting the fact that the overall level of education has increased over time.

Maps I and II provide evidence on the close correlation between the regional share of highly qualified workers and the average wage earned by highly qualified workers within each of the 75 regions in Western Germany. High average wages and human capital intensities follow the well-known 'hot banana pattern', i.e., they follow an imaginary line starting in the North-West in the Rhineland, crossing the Rhine-Main area and the automobile cluster around Stuttgart, and continuing down to the South-East to Bavaria. Employing the regional number of students and the number of schools as instrumental variables for the share of highly qualified workers in a region, Heuermann (2009) shows that while sorting effects play an important role for higher wages in human capital intensive regions, external effects from human capital raise wages of highly qualified workers by 1.8 percent with each additional percentage point in the share of highly qualified workers. Thus, a rise in the regional share of highly qualified workers by one standard deviation is associated with an increase in wages of about eight percent for highly qualified workers. In the subsequent analysis we investigate the extent to which wage effects from human capital externalities are attributable to a higher matching efficiency in skilled regions.

[5] Quits from the sample can occur if workers change into the public service, become self-employed, become unemployed, or leave the labor force altogether.

III. Matching as a Microeconomic Source of Human Capital Externalities

III.1. Between-Job Wage Adjustment: Evidence from a Balanced Panel

Graph I illustrates the evolution of average wages for the group of job changers in the balanced sample of workers. With the exception of 2004, average wages increase over the whole period of observation at an average annual rate of 1.5 percent. Of particular interest is the wage jump occurring at the time of job change, i.e., between 1999 and 2000, where average wages rise by about four percent from below 118 to above 122 Euros. In what follows we examine the extent to which this wage growth is driven by the local aggregate level of education.

Table II contains the results from estimating equation (1). All coefficients on individual characteristics are in line with the empirical literature, i.e., wages grow at a decreasing marginal rate with age, tenure, and experience; university graduates receive a wage premium of about eight percent compared to graduates from technical colleges, and women's wages are 37 percent below men's wages. These coefficients are constant across all wage regressions in both samples.

All columns consistently show that workers changing jobs in 2000 incur substantial wage gains from human capital externalities. While the overall effect of the regional share of highly qualified workers on wages of all workers ('*Regional Share HQ*') is insignificant throughout all regressions, the significantly positive coefficient on the interaction term ('*Job Change*Regional Share HQ*') in Column I indicates that wages of job changers rise by .35 percent with each additional percentage point of highly qualified workers in the local workforce. Thus, an increase in the share of highly qualified workers by one standard deviation (5.5 percentage points) is associated with wage gains of about two percent for the group of job changers.

In columns II to V we differentiate the impact of regional human capital on wages of job changers by year to examine whether wage gains occur in the year of a job change ('*Job Change*Regional Share HQ, 2000*'). The insight from all regressions is that on the incidence of a job change workers experience wage gains of between .27 and .58 percent with each additional percentage point of highly qualified workers in the local workforce. Thus, an increase in the share of highly qualified workers by one standard deviation raises wages of job changers by up to 3.2 percent, indicating that improved matching opportunities in skilled regions are likely to be of importance as a microeconomic mechanism behind the occurrence of human capital externalities.

In column III, we differentiate the impact of regional aggregate education ('*Regional Share HQ*') by year to control for changes in the size of human capital externalities over time which might be picked up by the interaction term. Coefficients, which are not shown here, are insignificant for each year. Finding the coefficients on the interaction terms to remain unchanged indicates that wage effects from human capital externalities are incurred exclusively by workers changing jobs.

In column IV, we additionally split up the job change dummy by year in order to control for changes in systematic differences between job changers and stayers over time. Doing so, wage gains from aggregate human capital double in the year of a job change, but lose significance thereafter, suggesting that aggregate wage effects from human capital externalities arise from a level, rather than from a growth effect. Coefficients on the job change dummies, which are not shown here, are significantly negative in the first two years of observation, and positive in the four years thereafter. These results are in line with findings by Lehmer/Möller (2008) and Freedman (2008) who show that low-paid workers are not only more likely to change jobs but also to accept wage losses when changing jobs as they expect to benefit from steeper wage growth through improved career opportunities thereafter.

In column V we include industry dummies to control for wage effects which might arise if workers in skilled regions self-select into higher paying industries. We have not controlled for industry effects in columns I to IV because industry classifications are incomplete between 2000 and 2003 and are missing altogether from 2003 onwards. When controlling for a potential self-selection of workers we find the results to remain constant, i.e., wages of job changers rise by about .6 percent with every additional percentage point of highly qualified workers in the local workforce.

A word of caution is in order with respect to the insignificance of overall wage effects from aggregate human capital (i.e., wage effects from aggregate human capital incurred by all workers independent of whether they change jobs or not) which may be driven by the short time horizon covered by the sample, rather than by the absence of genuine human capital externalities for job stayers. In fact, effects from aggregate human capital can arise only from intra-regional shifts in aggregate education since level effects are captured by regional fixed effects. As the sample covers a period of six years only, intra-regional variances in the share of highly qualified workers may be too small to yield significant effects.

III.2. Between-Job Wage Adjustment: Evidence from an Unbalanced Panel

To corroborate the results from the balanced sample and to examine whether matching externalities from aggregate human capital vary with the number of prior

job changes we employ the second, unbalanced panel of workers. Instead of comparing the development of wages of a group of job changers to that of stayers, we now compare wage gains on the incidence of a job change to wage developments of workers staying in their job. Technically, the job change dummy does not identify a worker as a jab changer anymore, but indicates the incidence of a job change.

In column I of Table III the results from the balanced sample are confirmed. Wages of job changers rise by between .2 and .3 percent at the time of a job change with each additional percentage point in the regional share of highly qualified workers. Hence, an increase in the regional share of highly qualified workers by one standard deviation is associated with wage gains of between 1.1 and 1.7 percent. In line with the results from the first sample, without human capital externalities job changers would incur wage losses of about .02 to .05 percent in the year after changing jobs, again indicating a self-selection of job changers.

Column II shows the results from running the same regression for the full sample of workers, including those workers who change jobs across regions. In this sample, matching effects from aggregate human capital disappear. As discussed above, three mechanisms are likely to explain these results. First, since aggregate education has been shown to unfold amenity effects, workers might be willing to accept lower wages when moving to skilled regions. Such wage depressing amenity effects counteract productivity effects from human capital. Second, workers changing regions are likely to be self-selected with respect to motivation and ambition. If more motivated workers move to regions with larger human capital endowments, matching effects cannot be disentangled from wage effects arising from higher motivation, i.e., they might be captured by the move dummy. Finally, these results may reflect the localized nature of career networks found in the literature. While not definite on the issue, the fact that workers who change regions do not incur wage gains from regional human capital endowments is in line with the notion that career networks work best if workers change jobs on a regional scale.

In column III, the occurrence of wage gains from local aggregate human capital is differentiated by the number of prior job changes. Since the number of observations decreases for job changes of higher ranks, all job changes above the third one are merged into one single category. The results show that wage gains increase from the first to the second job change and become insignificant thereafter. This finding is closely in line with the empirical results by Bartel/Borjas (1981) and Lehmer/Ludsteck (2010) who argue that workers learn about job and career opportunities early in their working life and capitalize on this knowledge through improved job matching opportunities when changing jobs. However, two caveats

apply. First, a decreasing number of observations on job changes of higher ranks implies that standard errors increase with the rank of each job change. Hence, different levels of significance may arise for statistical reasons, rather than reflect true differences in wage effects across different ranks of job changes. Secondly, career perspectives have been shown to play a dominant role as a motive for job change first and foremost in earlier stages of a workers life (Young 1993). Consequently, career networks might lose importance over time not because they transmit less usable information, but because workers' motives for changing jobs become more diverse over time. In sum, while the results on higher ranks of job changes need validation from other data sets, the findings from the wage regressions support the notion that productivity enhancing human capital externalities arise through improved matching opportunities in skilled regions.

Results obtained so far provide insight into the relative importance of matching externalities as a microeconomic source of human capital externalities. The regressions in Table III show that wages rise by up to .5 percent with each additional percentage point of highly qualified workers, independent of whether workers change jobs or not. Such productivity enhancing effects are, however, prone to be underestimated since with the existence of amenity effects workers are willing to accept wage losses in return for being close to other skilled workers (Roback 1982). According to Shapiro (2006), productivity effects account for about two thirds of the social returns to human capital and amenity effects for the remaining third. Thus, productivity effects from aggregate human capital are likely to be in the range of .8 percent for all workers. Job changers incur another .3 percent with each additional percentage point in the regional share of highly qualified workers at the time of changing firms. As workers in this sample change jobs only within regions, wage gains on the incidence of a job change are not influenced by amenity effects and simply reflect increases in productivity. Hence, wages of job changers rise by 1.1 percent with each additional percentage point of highly qualified workers in the workforce. With .3 percent points of this effect arising at the time of a job change, matching effects from aggregate human capital account for about thirty percent of overall productivity enhancing returns to human capital, which is in line with a dynamic interpretation of localized economies of scale. In fact, in the literature on agglomeration externalities it is increasingly acknowledged that productivity effects from economic density are mainly incurred by workers reaping the gains from better matching opportunities in urban areas. In this vein, Yankow (2006: 160) argues that "coordination efficiencies in dense urban settings have a prominent role to play in any comprehensive explanation of the urban wage premium". Analogously, human capital externalities partly arise from improved labor market coordination in skilled regions.

III.3. The Probability of Job Changes

Table IV contains the results from Probit regressions on the individual and aggregate determinants of a job change using both samples of workers. The first sample is restricted to the year 2000, because due to the way the sample is constructed job changes can only occur in that year. The subsample contains a cross-section of 18,409 workers, out of which 1,143 change jobs. This restriction impedes the use of time or region fixed effects. The second sample encompasses all 155,272 observations. The dependent variable throughout all regressions is the incidence of a job change.

Due to differences in the samples (with the first sample covering all workers in 2000 and the second sample consisting of observations on young workers between 1976 and 2004) the coefficients on individual variables vary between the two samples. However, all coefficients show the same plausible signs across all regressions. Age and experience follow an inverted U-shape pattern, indicating that the probability of a job change first increases with age and labor market experience and then declines again (see Battu/McMaster/White, 2002, for similar results). The probability of a job change decreases with tenure, which is consistent with the theoretical argument by Jovanovic (1979) and empirical findings by Mincer/Jovanovic (1981) and Farber (1999) which suggest that the disclosure of information on the quality of a job match is initially high and declines over time. Women change jobs more often than men; finally, there is no difference in job change behavior between university graduates and graduates from technical colleges.

In the first sample, we find no evidence for workers to change jobs more often in skilled regions. The impact of regional education levels on wages is, however, likely to be confounded by region and time specific shocks which cannot be controlled for in this cross-section of workers. Accordingly, when employing region and time fixed effects in the second sample we find regional education levels to exert a significantly positive influence on the probability of a job change. An increase in the share of highly qualified workers by one standard deviation raises the annual probability of a job change by between .2 and .4 percentage points.

Graph II shows the results from a simulation of the probability of job change as a function of regional human capital endowments, which is based on the specification in column III. The probability increases monotonically at a growing marginal rate within the observable range of regional human capital levels. A rise in the regional share of highly qualified workers by one standard deviation to its mean in 2004, i.e., from three to eight percent, is associated with an increase in the job change probability of about .1 percentage points. With a rise from eight to thirteen percent this probability increases by more than .3 percentage points. With an annual average

probability of about 6.7 percent for a worker to change jobs, this corresponds to an increase of about 4.5 percent. Workers in regions with a share of highly qualified workers exceeding seventeen percent are about one percentage point, i.e., sixteen percent, more likely to change jobs in a given year compared to workers in regions with a share of highly qualified workers below five percent.

Finding job change probabilities to increase more than proportionally with the local aggregate level of human capital suggests that career networks are predominantly an issue of a number of 'high-skill hubs' located at the upper end of the distribution, whereas for intermediate levels of aggregate human capital matching effects are not very large. Typically, regions with high shares of qualified workers are characterized by clusters of industries. Munich (share of highly qualified workers: 21.7 %; industry cluster: computer engineering), Frankfurt (18.7 %; banking), Stuttgart (15.7 %; automobile industry), and Ludwigshafen (15%; chemical industry) are a point in case here. Hence, it is likely that the size of matching effects does not only depend on the level of regional human capital, but also on the extent to which regional industrial compositions allow workers to change jobs within industries and thereby capitalize on their industry-specific human capital. In line with this notion, Fallick/Fleischman/Rebitzer (2006) provide evidence that high job-hopping rates in Silicon Valley identified by Saxenian (1994) are entirely driven by job changes within the computer industry, while job changing rates within other industries are not significantly higher than elsewhere. In what follows we examine the importance of within-industry job changes for the occurrence of matching externalities.

IV. Human Capital Externalities and the Transfer of Industry-Specific Knowledge

The results obtained so far support the idea that human capital externalities partly arise from an improved matching efficiency in skilled regions. Among other things, the quality of a labor market match depends on the extent to which workers can transfer their knowledge and experience to a new environment and thereby continue to use it productively. Studies in the literature on agglomeration externalities have shown that benefits from urban density are to some extent rooted in the fact that cities are home to larger industries, which facilitates the transfer of industry-specific knowledge between jobs (Freedman 2008, Wheeler 2008). Analogously, individual networks might allow workers in skilled regions to continue their career in the same industry and to thereby capitalize on their knowledge and experience obtained in past jobs. Examining this issue we first investigate whether wage gains from aggregate human capital are larger for workers changing jobs within industries. We then

analyze whether workers are more likely to stay within an industry in human capital intensive regions when changing jobs than workers in less skilled regions.

Column IV in Table III indicates that matching effects from aggregate human capital only arise for workers changing jobs within an industry. When disaggregating the interaction term by the rank of each job change we find that in line with our prior results matching externalities arise predominantly with the first two intra-industry job changes and become insignificant thereafter (results not shown here). With respect to the importance of career networks, this finding suggests that such networks carry information about job opportunities within industries and thereby increase the chances of workers to capitalize on their industry-specific human capital early in their career. While it may be the case that intra-industry and between-industry changers differ systematically in their motives of changing jobs, such self-selection effects are likely to be captured by the job change dummies rather than by the interaction term, which is subject to the assumption that the unobserved heterogeneity between workers does not vary systematically with the density of human capital.

If wage gains only arise for workers changing jobs within an industry, workers in human capital intensive areas should be more likely to change jobs within industries in order to reap the gains from matching externalities. We examine this issue by estimating the probability of a worker to change industries (conditional on changing jobs) as a function of regional human capital. For this analysis the two samples are reduced to their respective subsamples of job changers.

Column I in Table V shows that for the first sample the probability of a job changer to change industries declines with the regional share of highly qualified workers. This result is, however, not robust to the inclusion of the regional degree of agglomeration as a further control. Since this regression is based on a relatively small number of observations, identification is likely to be impeded by the collinearity between human capital density and agglomeration.

The results from the second sample, which are contained in columns II to IV, show that workers changing jobs in skilled regions are less likely to change industries than workers in regions with a low share of highly qualified workers. In contrast to the first sample, this result is robust to the inclusion of increasing returns to agglomeration. A rise in the regional share of highly qualified workers by one standard deviation is associated with a decrease in the probability of a worker to change industries by about ten percentage points. With a regional share of highly qualified workers below five percent, the overall probability of a worker to change industries when changing jobs is around sixty percent. In regions characterized by a share of highly qualified workers of above fifteen percent this probability decreases to

below forty percent. Inspired by Wheeler (2008), who finds that the probability of a worker to change industries in urban areas decreases with the number of prior job changes, we split up the probability of an industry change by the rank of each job change. In line with Wheeler, column IV shows that the negative impact of the regional level of human capital on the probability of an industry change is significant especially early in a worker's career.

In sum, the general picture emerging from this analysis is that a high regional density of highly qualified workers enables university graduates to gather information on superior job matches during the early stages of their careers and to thereby capitalize on their industry-specific human capital acquired so far. Hence, it seems that it is through the opportunity of changing jobs within industries that regional human capital enables workers to climb up the income ladder more quickly in skilled regions.

V. Conclusion

In this study we set out with the intent to shed light on the microeconomic foundations of human capital externalities. Inspired by the literature on the importance of social networks for career perspectives we have investigated whether the local aggregate level of education unfolds productivity effects through an improved quality of job matches in human capital rich regions. Employing two samples of highly qualified workers in Germany we have examined the extent to which regional differences in between-job wage growth and in job changing behavior are attributable to differences in regional educational endowments as measured by the share of highly qualified workers. Our results support the notion that regional human capital externalities are partly rooted in improved job matching opportunities in skilled regions. Three core findings emerge from the analysis:

First, an increase in the share of highly qualified workers by one standard deviation is associated with wage gains of job changers between 1.5 to 3.2 percent and, second, with an increase in the annual probability of a job change by up to four percent. Third, between-job wage gains accrue only to workers changing jobs within industries and, consistently, workers in human capital intensive areas are more likely to change jobs within rather than between industries. These findings suggest that human capital externalities partly arise because workers in skilled regions are able to capitalize on their industry-specific human capital to a larger extent than workers in less skilled regions.

Given the significance of improved job matching opportunities as a microeconomic foundation of human capital externalities, further research on human capital externalities is encouraged to go beyond a mere quantification of external effects from

human capital and to further our understanding of the microeconomic sources of human capital externalities. In this respect we regard the taxonomy by Duranton/Puga (2004) of sharing, matching, and learning mechanisms, as well as the empirical study by Charlot/Duranton (2004) on the importance of workplace communication for human capital externalities, as ideal starting points.

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Appendix

Table I – Descriptive Statistics

	Sample I		Sample II	
	Mean	Standard Deviation	Mean	Standard Deviation
Daily Gross Wage	135.78	43.75	115.12	38.67
Age	42.5	8.4	33.3	6.4
Tenure	7.7	6.5	5.7	5.3
Experience	14.5	7.2	8.4	6.3
Share of Females	.25	-	.27	-
Regional Share of Highly Qualified Workers	.12	.04	.10	.04
Regional Number of Workers	12,081	7,230	12,137	7,108

Table II – Do Workers Benefit from Regional Human Capital when Changing Jobs?

	Dependent Variable: Ln(Individual Daily Gross Wage)				
	(I)	(II)	(III)	(IV)	(V)
Age	.006 (.002)***	.006 (.002)***	.006 (.002)***	.006 (.002)***	.009 (.002)***
Age^2	-.0001 (.00002)***	-.0001 (.00002)***	-.0001 (.00002)***	-.0001 (.00002)***	-.0001 (.00002)***
Experience	.012 (.001)***	.012 (.001)***	.012 (.001)***	.012 (.001)***	.012 (.001)***
Experience^2	-.00003 (.00003)	-.00003 (.00003)	-.00002 (.00002)	-.00002 (.00003)	-.00004 (.00004)
Tenure	.004 (.0007)***	.004 (.0007)***	.004 (.0007)***	.004 (.0007)***	.004 (.0008)***
Tenure^2	-.00007 (.00002)***	-.00008 (.00002)***	-.00008 (.00002)***	-.00008 (.00002)***	-.00007 (.00003)**
Female	-.369 (.003)***	-.369 (.003)***	-.369 (.003)***	-.369 (.003)***	-.326 (.004)***
University Degree	.083 (.002)***	.083 (.002)***	.083 (.002)***	.083 (.002)***	.080 (.003)***
Regional No of Workers	-.003 (.004)	-.004 (.004)	-.003 (.005)	-.002 (.005)	-.003 (.007)
Regional Share HQ	-.346 (.357)	-.444 (.357)	Split up by Year, results not shown	Split up by Year, results not shown	Split up by Year, results not shown
Job Change	-.056 (.016)***	-.047 (.016)***	-.047 (.016)***	Split up by Year, results not shown	Split up by Year, results not shown
Job Change*Regional Share HQ	.345 (.118)***	Split up by Year	Split up by Year	Split up by Year	Split up by Year
Job Change*Regional Share HQ, 1999	-	-.029 (.156)	-.038 (.156)	.341 (.348)	.224 (.337)
Job Change*Regional Share HQ, 2000	-	.268 (.145)*	.269 (.146)**	.582 (.299)**	.588 (.297)**
Job Change*Regional Share HQ, 2001	-	.329 (.147)**	.331 (.147)**	.066 (.297)	.119 (.300)
Job Change*Regional Share HQ, 2002	-	.397 (.138)***	.401 (.138)***	.232 (.277)	.289 (.279)
Job Change*Regional Share HQ, 2003	-	.385 (.132)***	.383 (.132)***	.346 (.267)	-
Job Change*Regional Share HQ, 2004	-	.320 (.133)***	.319 (.133)***	.144 (.274)	-
Year Dummies	Yes	Yes	Yes	Yes	Yes
Region Dummies	Yes	Yes	Yes	Yes	Yes
Industry Dummies	No	No	No	No	Yes
Sample	Sample I, All Workers Staying in a Region	Sample I, All Workers Staying in a Region	Sample I, All Workers Staying in a Region	Sample I, All Workers Staying in a Region	Sample I, All Workers Staying in a Region
Adj. R^2	.24	.24	.24	.24	.27
No. of Observations	110,454	110,454	110,454	110,454	68,151

Notes: Robust standard errors in parentheses; ***, **, and * indicate significance at the 1% level, the 5% level, and the 10% level respectively; coefficients for constants are not reported here; coefficients and standard errors for Regional Number of Workers are multiplied by 1,000; the education variable equals 0 for '*Degree from a Technical College*' and 1 for '*Degree from a University*'; the variable Female equals 0 for '*Male*' and 1 for '*Female*'.

Table III – Do Workers Benefit from Regional Human Capital when Changing Jobs?

	Dependent Variable: Ln(Individual Daily Gross Wage)			
	(I)	(II)	(III)	(IV)
Regional Share HQ	.501 (.123)***	.398 (.093)***	.501 (.123)***	.501 (.123)***
Regional No of Workers	-.004 (.001)***	-.003 (.001)**	-.004 (.001)***	-.004 (.001)***
Job Change Dummy	-.016 (.009)	.019 (.005)***	-	-
Job Change*Regional Share HQ	.183 (.087)**	.049 (.051)	-	-
1st Job Change	-	-	-.010 (.012)	-
2nd Job Change	-	-	-.056 (.020)***	-
3rd Job Change	-	-	-.009 (.035)	-
4th Job Change	-	-	-.153 (.059)	-
1st Job Change*Regional Share HQ	-	-	.242 (.107)**	-
2nd Job Change*Regional Share HQ	-	-	.424 (.167)**	-
3rd Job Change*Regional Share HQ	-	-	-.128 (.299)	-
4th Job Change*Regional Share HQ	-	-	-.196 (.503)	-
Intra-Industry Job Change	-	-	-	-.031 (.015)**
Inter-Industry Job Change	-	-	-	-.003 (.013)
Intra-Industry Job Change*Regional Share HQ	-	-	-	.331 (.128)***
Inter-Industry Job Change*Regional Share HQ	-	-	-	.053 (.114)
Year Dummies	Yes	Yes	Yes	Yes
Region Dummies	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes
Sample	Sample II, All Workers Staying in a Region	Sample II, All Workers	Sample II, All Workers Staying in a Region	Sample II, All Workers Staying in a Region
Adj. R^2	.33	.32	.33	.33
No. of Observations	123,522	217,109	123,522	123,522

Notes: Since coefficients on individual attributes are similar to those in Table I, they are not displayed here; robust standard errors in parentheses; ***, **, and * indicate significance at the 1% level, the 5% level, and the 10% level respectively; coefficients for constants are not reported here; coefficients and standard errors for Regional Number of Workers and interactions terms containing Regional Number of Workers are multiplied by 1,000.

Table IV – Does Regional Human Capital Increase the Probability of Intra-Regional Job Changes?

	Dependent Variable: Incidence of Job Change			
	(I)	(II)	(III)	(IV)
Age	.0001	.001	.001	.001
	(.0001)	(.0002)***	(.0002)***	(.0002)***
Age^2	-.00001	-.0007	-.0007	-.0007
	(.00001)	(.0002)**	(.0002)**	(.0003)**
Experience	.0003	.003	.003	.003
	(.0002)*	(.0003)***	(.0003)***	(.0003)***
Experience^2	-.003	-.0001	-.0001	-.0001
	(.0005)	(.00001)***	(.00001)***	(.00001)***
Tenure	-.003	-.009	-.009	-.009
	(.001)**	(.0009)***	(.0009)***	(.0009)***
Tenure^2	.00009	.0003	.0003	.0003
	(.00004)**	(.00003)***	(.00003)***	(.00003)***
Female	.00005	.001	.001	.001
	(.0001)	(.0002)***	(.0002)***	(.0002)***
University Degree	-.0001	.0003	.0003	.0003
	(.0001)	(.0001)*	(.0001)*	(.0001)*
Regional Share HQ	.003	.016	.021	.042
	(.003)	(.007)***	(.008)***	(.023)**
Regional Share HQ^2	-	-	-	-.061
				(.060)
Regional No of Workers	.002	-	-.123	-.512
	(.002)		(.082)	(.455)
Regional No of Workers^2	-	-	-	.000001
				(.000001)
Year Dummies	No	Yes	Yes	Yes
Region Dummies	No	Yes	Yes	Yes
Sample	Sample I, All Workers in 2000 Staying in a Region	Sample II, All Workers Staying in a Region	Sample II, All Workers Staying in a Region	Sample II, All Workers Staying in a Region
Adj. R^2	.49	.46	.46	.46
No. of Observations	18,409	155,272	155,272	155,272

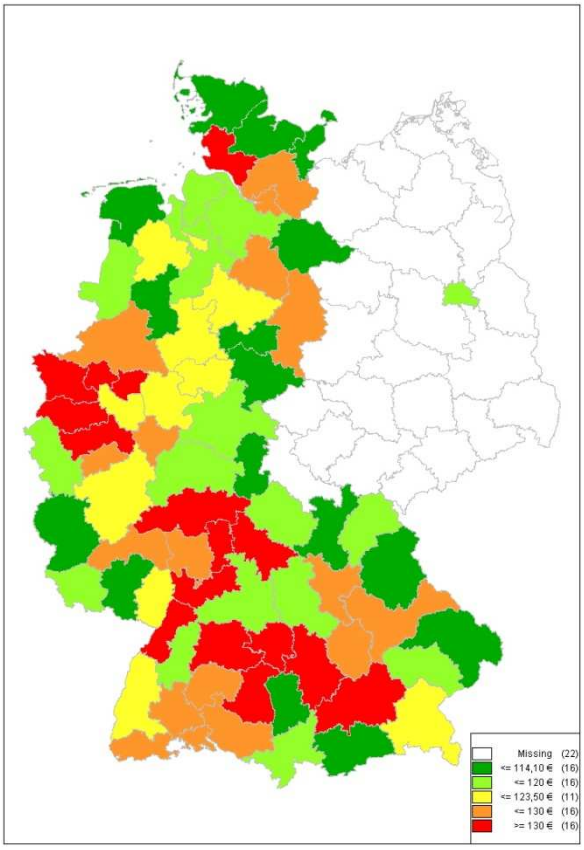
Notes: Robust standard errors in parentheses; ***, **, and * indicate significance at the 1% level, the 5% level, and the 10% level respectively; coefficients for constants are not reported here; coefficients and standard errors of Regional No of Workers, as well as of squares thereof, are multiplied by 1,000,000; the education variable equals 0 for '*Degree from a Technical College*' and 1 for '*Degree from a University*'; the variable Female equals 0 for '*Male*' and 1 for '*Female*'.

Table V – Do Workers Change Industries More/Less Frequently in Human Capital Intensive Regions?

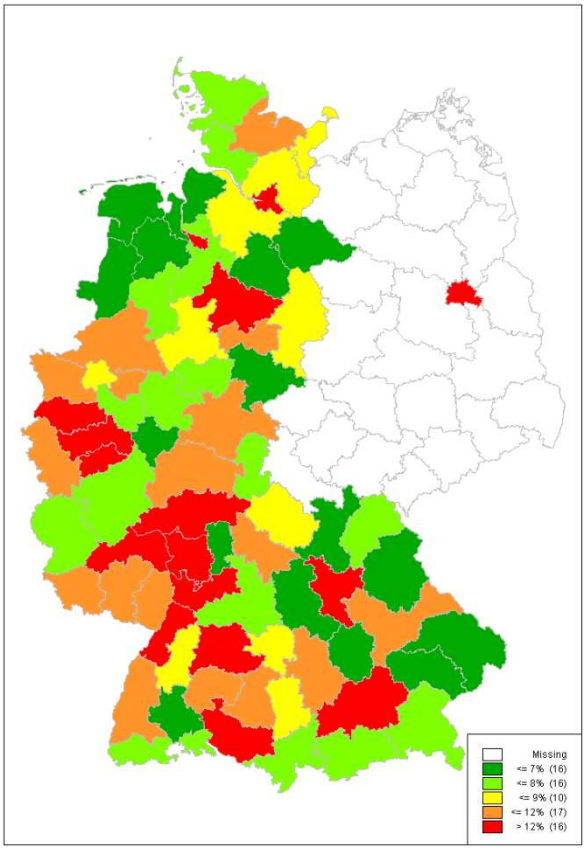
	Dependent Variable: Incidence of Industry Change, Conditional on Job Change			
	(I)	(II)	(III)	(IV)
Age	-.003 (.020)	-.014 (.012)	-.015 (.012)	-.015 (.012)
Age^2	.00002 (.0002)	.0002 (.0002)	.0001 (.0002)	.0002 (.0002)
Experience	-.016 (.011)	.006 (.005)	.006 (.005)	.005 (.005)
Experience^2	.0002 (.0004)	-.0004 (.0002)**	-.0004 (.0002)**	-.0004 (.0002)**
Tenure	-.028 (.021)	-.014 (.009)	-.014 (.009)	-.016 (.009)
Tenure^2	.002 (.001)	.0009 (.0006)	.0009 (.0006)	.001 (.0006)
Female	.057 (.034)*	-.011 (.012)	-.011 (.012)	-.012 (.012)
University Degree	.022 (.032)	-.014 (.012)	-.015 (.012)	-.015 (.012)
Regional Share HQ	-.838 (.397)**	-1.60 (.607)***	-1.42 (.691)***	-
Regional No of Workers	-	-	-.004 (.008)	-.004 (.008)
1st Job Change	-	-	-	-.020 (.083)
2nd Job Change	-	-	-	-.051 (.086)
3rd Job Change	-	-	-	-.033 (.096)
1st Job Change *Regional Share HQ	-	-	-	-1.60 (.709)**
2nd Job Change*Regional Share HQ	-	-	-	-1.29 (.723)*
3rd Job Change*Regional Share HQ	-	-	-	-1.16 (.788)
4th Job Change*Regional Share HQ	-	-	-	-1.53 (.902)
Year Dummies	No	Yes	Yes	Yes
Region Dummies	No	Yes	Yes	Yes
Sample	Job Changers within Regions, Sample I	Job Changers within Regions Sample II	Job Changers within Regions Sample II	Job Changers within Regions Sample II
Pseudo R^2	.025	.071	.071	.071
No. of Observations	1,143	9,716	9,716	9,716

Notes: Robust standard errors in parentheses; ***, **, and * indicate significance at the 1% level, the 5% level, and the 10% level respectively; coefficients for constants are not reported here; coefficients and standard errors of Regional No of Workers as well as of squares thereof are multiplied by 1,000; reference groups for job change dummies is '*Fourth or More Job Change*'; the education variable equals 0 for '*Degree from a Technical College*' and 1 for '*Degree from a University*'; the variable Female equals 0 for '*Male*' and 1 for '*Female*'.

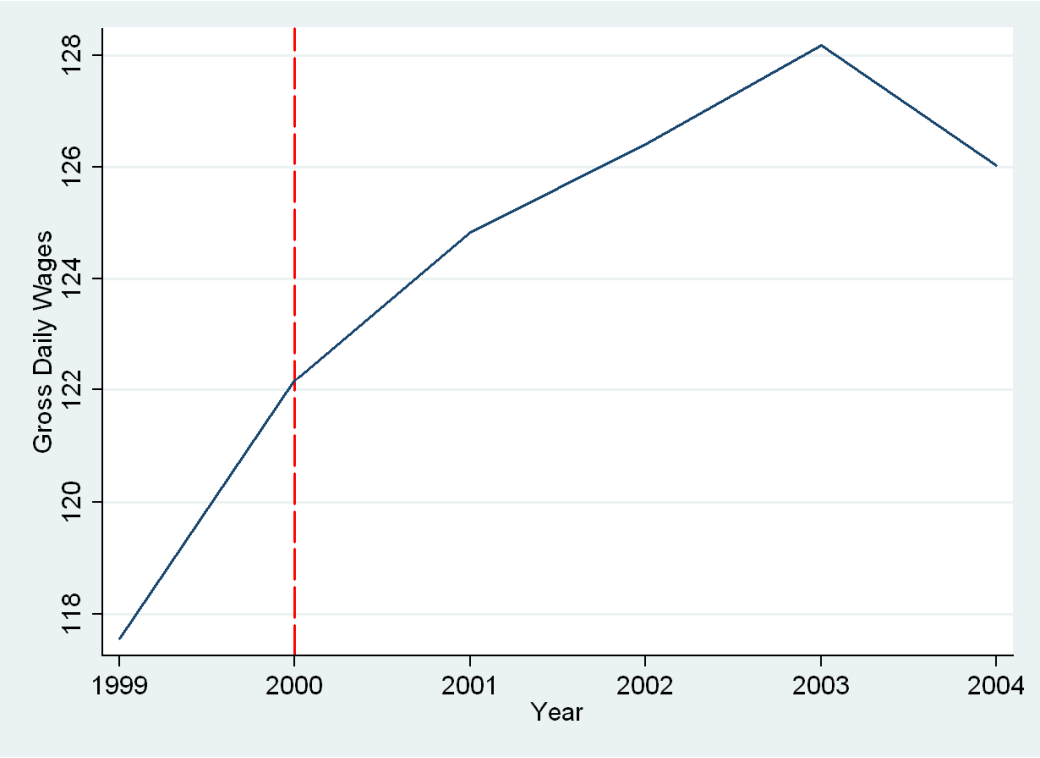
Map I: Average Regional Wages of Highly Qualified Workers, 2001



Map II: Regional Share of Highly Qualified Workers, 2001

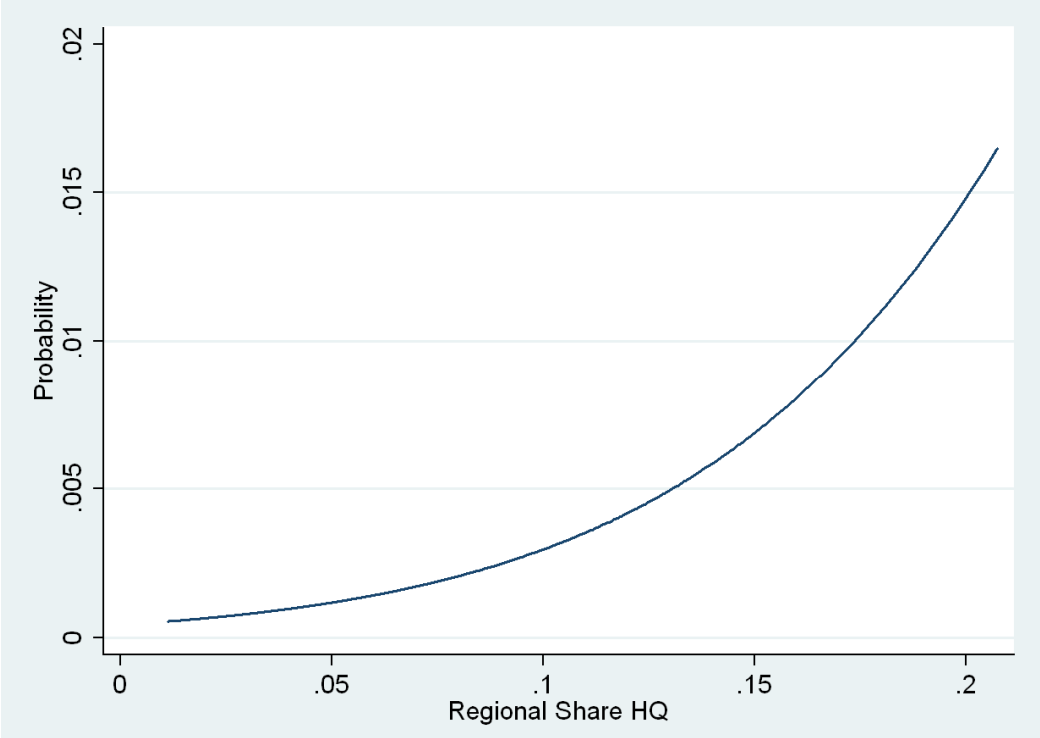


Graph I: Wage Development of Job Changers



The graph displays annual average wages of all individuals in sample I changing jobs in 2000.

Graph II: The Probability of a Job Change as a Function of Regional Human Capital



The graph displays the results from a simulation of job changing probability as a function of regional human capital endowments, based on the results contained in Column III in Table IV.

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