Potential for Knowledge Transmission through Job-to-job Mobility of Highly Qualified Workers

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Abstract

This empirical study has two purposes. The first one is to evaluate the potential for knowledge dissemination through labour mobility in the German economy based on a number of theoretical considerations. The second purpose is to explore the industry-specific factors that influence the level of highly qualified workers’ mobility within three-digit industrial sectors. To understand the potential for knowledge transfer through labour mobility we utilize the theories of search and matching, the human capital theory and the theory of interactive learning. We find that the general level of highly qualified workers’ mobility in Germany is surprisingly high. However, simply looking at the level of general mobility in order to assess the potential of this knowledge transmission channel may be misleading because, as we argue in the study, not all job-to-job movements of highly qualified workers may be likely to transmit innovation-relevant knowledge. For few different theoretical reasons we consider the highest potential for knowledge transmission to lay within voluntary intra-industry job-switches. This subset of mobility is, we find, dependent on technology- and industry’s evolution-specific factors. We find a significant effect of the technological regime and the level of job destruction on the level of voluntary highly qualified workers’ mobility. The overall intra-industry mobility of this group is mainly affected by the level of job destruction, but also by factors such as geographical concentration of an industry and firm-size effects.
Potential for Knowledge Transmission through Job-to-job Mobility

Introduction

The literature on knowledge spillovers (Griliches, 1979) became more precise about the channels of knowledge transmission in the last two decades. Knowledge exchange comes about either through direct contact of people (informal communication, cooperation, training, acquiring of people or groups of people) or through analysis of product-embedded knowledge (publications, licenses, patents and final products). Malerba and Orsenigo (1997) name the earlier direct and the latter indirect means of knowledge transmission (p. 96). After acknowledging the distinct character of knowledge that unlike information is often remarkably difficult to convey without direct and repeated communication, the direct means of knowledge transmission gained an increasing attention in the theory of innovation.

The purpose of this study is to “zoom-in” one of these channels-the job-to-job mobility of highly qualified workers. Remarkable intra-industry job-to-job mobility of engineers and other highly qualified workers has been observed in several empirical studies, primarily case studies focusing on dynamic, innovative clusters (Saxenian, 1994; Keeble et al. 1998; Henry and Pinch, 2000). These studies acknowledge the merits of the workers’ mobility for the growth of these regions. Other studies associate the growth of industries with the high mobility of technical personnel (Cooper, 2000; Franco and Filson, 2000; Klepper, 2002; Klepper and Sleeper, 2005).

The phenomenon of job-to-job mobility of workers in general has been extensively explored both theoretically and empirically within the human capital and within the search and matching theories. However, their focus has not been on knowledge dissemination and therefore some relevant aspects of mobility remain insufficiently researched. Only recently, as notably relevant for the economics of innovation, a number of models elaborated the implications of labour mobility as knowledge carrier (Cooper, 2000; Franco and Filson, 2000; Fosfuri and Rønde, 2003; Fallick et al., 2004; Combes and Duranton, 2005). Empirical evidence of the knowledge transmission through mobility of inventors has been established by analysis of the patent citations (Jaffe et al., 1993; Almeida and Kogut 1999). While it is clear that not only inventors are responsible for innovation-relevant knowledge transmission, it is also explicit that the pool of knowledge dissemination.

1 The focus of these theories has been issues such as unemployment, wages and investment in education and training.
workers who have an access to innovation-relevant knowledge in a firm is limited. This is why our study focuses on the highly qualified workers (HQW)\(^2\) as potential carriers of innovation-relevant knowledge.

To justify a separate study on mobility of highly qualified workers the first step was to investigate whether the mobility behavior of HQW significantly differs from the one of non-HQW. Previous studies discriminating between different educational and skill groups yield differing results\(^3\). As we find significant differences in the intra-industry mobility of HQW vs. non-HQW, we proceed the research by focusing on HQW only.

The structure of the paper is as follows. In section I we explain why it may be important to distinguish between voluntary and involuntary mobility for the potential of knowledge transmission and how the theories of search and matching, as well as the human capital theory help us in understanding this. In this section we further justify why it is relevant to set industry borders in the analysis of mobility. In section II we focus on few industry-specific variables that we believe have a major impact on the mobility dynamics of HQW. In section III we present our empirical strategy and its results. Section IV concludes.

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\(^2\) Operationally we define HQW as workers employed in the observed industry with at least college degree (Fachhochschule Abschluss) whose average earnings in each consecutive year are at least as high as the average earnings for the economy. The earnings limitation is an attempt to eliminate that group of highly educated people who are underemployed. This group of workers due to working at positions where workers are less exposed to strategic information and knowledge is less likely to contribute to the knowledge transmission. We also only consider the employment spells where the employee is full-time employed.

\(^3\) Many studies found higher mobility levels of people with higher qualifications (e.g. Weißhuhn, 1987; Velling and Bender, 1994) while other find no difference in the mobility levels for different educational categories (Mühleisen and Zimmermann 1994, Zimmermann 1998)
I. Borders of the potential for knowledge transmission among firms

A. Voluntary and involuntary mobility

We derive the importance to distinguish between voluntary and involuntary mobility for the potential of knowledge dissemination from the search and matching theory, as well as the human capital theory. Discriminating between voluntary and involuntary mobility is important because voluntary mobility is led by the search for better employer-employee matches (e.g. Jovanovic, 1979) and therefore generates better-quality matches with higher probability when compared to involuntary mobility. Not contradicting the common understanding that job matches are experience goods, we believe that job matches are to large extent inspection goods as well (Hirshleifer, 1973). This means that the learning about the other side of the match happens before the “purchase”. This assumption is not unrealistic taking into consideration the contemporary selection processes where the applicants extensively evidence their past experience, skills, knowledge and qualifications at the job application stage. On the other side, job applicants actively collect information about the firm and the job position before they apply and agree on a job. Acknowledging job matches as an inspection good has the implication that both the employer and the employee become aware of the potential knowledge exchange that may take place in case of a successful match. In the search and matching theory a better-quality match translates into higher earnings for the employee and higher productivity for the firm. If a better-quality match results in higher productivity this may well be due to the higher complementarity of knowledge and competence of the both sides. This would mean that matches resulting from voluntary mobility are more likely to result in a higher utilization of the knowledge possessed by the worker, or in other words, higher knowledge transmission.

Another implication for the theory and the measurement of knowledge transmission is derived from the human capital theory (Becker, 1962, 1964). Involuntary mobile (at least in our definition) are often people who have experienced unemployment spells between two employment spells. Break in the employment may lead to significant human capital losses. In highly dynamic industries a break of several months may substantially depart the worker from updated information and knowledge about the ongoing processes in the former firm. Under the assumption that job
matches are inspection goods, the new employer should expect fewer spillovers from employees who return into employment after having experienced unemployment spell.

B. Intra- and inter-industry mobility

This part of the study utilizes the work of Bart Nooteboom (2000a, 2000b) on the theory of cognitive proximity and distance and explains the importance of this theory for our empirical investigation. Based on this theory, the section explicates why we conclude that the intra-industry mobility of HQW may be of particular interest and why looking at industries at the 3-digit level of the NACE classification\(^4\), although somewhat arbitrary defined, may well approximate our intentions.

Nooteboom thinks of knowledge in a broad sense, including perceptions, understanding and value judgments into its definition. Knowledge in this sense is dependent on the institutional environment, path-dependent and idiosyncratic to a certain extend (Nooteboom, 2000b, p. 71). Therefore, people coming from the same social and institutional background *ceteris paribus* should be better able to communicate knowledge with each other than people with different backgrounds. Cognitive proximity refers to the ability of people to understand each-others mental models, align cognitive categories and create a system of shared meaning (Nooteboom, 2000b, p. 71 f.). People are cognitive close to the extent they have observed the same set of phenomena, use similar thought processes to interpret these phenomena and draw similar inferences by observing them. This proximity decreases as the skill-profiles and the social backgrounds of workers become less related. However, the higher the cognitive proximity of people, the lower is the potential for learning from each other. Therefore, for knowledge exchange to take place it is important that the sides are not only cognitively close enough but also cognitively distant enough. On the other extreme, when people are cognitively distant from each other, meaning that there is little overlap in their set of observed phenomena, in the forms of thought they use and in the range of categorizations and inferences, it is difficult to communicate knowledge. Therefore, the cognitive distance has the merit of novelty, but the problem of incomprehensibility (p. 71).

\(^4\) Later in this paper (see section III) we explain that we do not strictly use the 3-digit NACE classification, but we merge technology-related, but small industries together mainly for statistical reasons, but also because labour markets borders expand beyond the borders of very narrowly-defined industries.
Nootenboom explains that firms trade-off between cognitive distance for the sake of novelty and cognitive proximity for the sake of efficient absorption.

Now, if a firm has to manage the contacts to other firms in order to expose itself to cognitively distant concepts and processes, how far can a firm search for novelty without losing the capability to comprehend the newness? Can it search among the firms within the niche, within the industry or can it comprehend models and thoughts coming from seemingly unrelated industries? More specifically, when acquiring workers, should a firm employ people with experience in the same industry or independently from the industrial affiliation? Worker’s experience in the same industry in Nootenboom’s sense would mean higher exposure to the same set of phenomena, and the same (or similar) institutional environment which facilitates higher cognitive proximity. At the same time, workers coming from the same industry are cognitively distant to the extent that the organizational culture, the technologies, the informal and the formal institutions, the strategies and the specializations among the firms differ. This means that workers coming from the same, broadly enough defined industry would be both, cognitively close enough so they can comprehend each other and cognitively distant enough so they can learn from each other.

When it comes to the potential for knowledge exchange between entities coming from different industries, the potential for novelty increases as the cognitive distance grows, but the problem of incomprehensibility may impede such novelty from taking place. Indisputable value lays in novelties that are a result of interacting disciplines which confirms the capability of people to exploit ideas at a large cognitive distance between the actors. However, the important question is: how intense should a knowledge transmission channel be in order to result in a sufficient overlap between ranges and domains of people with seemingly unrelated backgrounds? Acquisition of single individuals with experience in different industries may require significantly more effort in terms of communication and understanding than it would be the case of acquisition of people with background in the same industry. If, by the acquisitions of people from different industries, this effort is lacking, there will be insufficient exploration of the domains and the ranges of the involved sides and therefore lower potential for new combinations. We argue that labour mobility in a narrow sense may be an insufficient channel of knowledge transmission when it comes to bridging fundamentally different disciplines. R&D cooperation between firms, joint ventures and
other forms of intense cooperation that require high level of synergy should be a more intense channel of knowledge transmission\(^5\).

We consider intra-industry mobility as more likely to result in knowledge spillovers than inter-industry mobility when industries are defined broad enough to allow for optimal level of cognitive distance. We believe that observing industries at a three-digit serves this purpose well. We conclude the potential for knowledge dissemination through labour mobility accordingly.

### II. Technologies, technological change and mobility

#### A. Theoretical considerations

It is well known in the industrial dynamics literature that industries vary in many respects, both due to the differences in their technology and due to the evolutionary stage they are experiencing. These differences affect the labour dynamics, and to the extent they influence the mobility-related behavior of the highly qualified workers, they may be determining the level of knowledge diffusion as well.

*Technological regimes*

Schumpeter (1934, 1950) observed two technological regimes that characterize industries; the entrepreneurial one, where ‘creative destruction’ is the major innovation mode and the routinized one, where ‘creative accumulation’ underlies the innovative processes. According to the work of Nelson and Winter (1982), and later Malerba and Orsenigo (1990, 1993, and 1997), these two regimes differ along four major technology-related features: the opportunity and appropriability conditions, the degree of cumulativeness, and the knowledge base. The entrepreneurial regime is characterized by high opportunities, lack of appropriability, and low degree of cumulativeness.

\(^5\) Boschma et al. (2008) argue in a similar way and empirically confirm the theoretically proposed inverted U shape function between cognitive distance of mobile workers and the economic performance of firms. They find that inflows of skills from the same 3-digit industry (excluding the same 5-digit industry) had a positive effect on the performance of plants, while the inflows of skills from the same 5-digit industry had a negative impact. The inflows of skills from a different 3-digit industry had insignificant effect on plant productivity (p. 15).
Such conditions result in low concentration of innovative activities, large number of innovators, and high rates of entry (Malerba and Orsenigo, 1997, p. 100). The opposite conditions and outcomes prevail in the routinized regime. The major implication of these differing conditions is that under the entrepreneurial regime new and small firms have the innovative advantage, where under the routinized one the innovative edge is in the hands of incumbents.

We believe that the technological regime of an industry has an impact on the level of intra-industry mobility of highly qualified workers. All three features of the entrepreneurial regime: low concentration of innovation, large number of innovators and high rates of entry create conditions for much mobility of workers, both voluntary and involuntary. Low concentration of innovative activities means that numerous firms possess pieces of novel knowledge. Such situation creates an environment in which the incentives for knowledge exchange among firms are high, as multiple firms own innovation-relevant knowledge with high potential to result in useful combinations if connected. The large number of innovators indicates possibilities for the workers to move among the firms in search for better matches. High entry rates speak about new jobs being created and therefore new opportunities for movement from incumbents to newcomers.

**Turbulence**

As industries evolve, the entrepreneurial entry of firms, their exit, expansion, and contraction show different dynamics. Both, the industrial dynamics and the labour economics literature agree that the major force behind this development is technological change. The varying pattern of entry, survival and exit of firms has been proven for industries evolving around different product categories (Agarwal and Gort, 1996). Less is clear how the level of turbulence evolves in a multi-product industry (as it is in our case). Malerba and Orsenigo (1996) measure innovative turbulence for different technological classes and find that it is high for the industries in an entrepreneurial regime. However, unlike Malerba and Orsenigo (1996, 1997), we are more interested in the entrepreneurial entry and exit of firms, as well as their expansion and contraction, as these dynamics directly affect the transitions of workers among different employment states.
The term turbulence has been used to indicate various closely-connected phenomena in the industry dynamics literature and different measures of turbulence have been proposed. Therefore, it is essential to be clear about our notion and measures of turbulence. In our approach turbulence is closely related to the notions of job creation and job destruction common in the labour economics literature.\footnote{For a comprehensive explanation of these phenomena see Davis and Haltiwanger (1992) or Boeri and Cramer (1992).} This is the case when turbulence is measured in terms of employment changes due to entry, exits, expansions and contractions of firms. Therefore, instead of having a single measure of turbulence, we estimate the job creation and destruction rates, which we find more informative when explaining the forces of mobility.

Due to technological change and demand shifts jobs get reallocated from less to more productive firms, and from declining to growing industries. Worker flows happen as a consequence; workers transit from employment to unemployment or out of the labour force, from unemployment or out of labour force into employment and from one job to another (within or across industries). Such job-, and consequently, worker-flows are largely induced by the changes in the desired establishment size. As such, these changes act as exogenous factors that partially drive the workers’ movement from one job to another by creating opportunities and restrictions to voluntary mobility on one hand and pressure for involuntary mobility on the other.

Mainly based on the longitudinal research of the American economy, labour economists find that at any moment of time there is a high degree of both, job creation and job destruction (Davis and Haltiwanger 1992, 1999). Sectors that undergo a vivid technological change are characterized by simultaneous coexistence of high level of the above mentioned phenomena. New technology makes existing one obsolete resulting in both, closure of jobs developed around the old technology and creation of jobs emanating from the new one. In line with these results, we also find comparatively high levels of job creation and destruction in the German economy. The median rate of job creation within industries is 7.5 \%, while the median rate of job destruction is 8.4\% for the five-year period under observation. The rates of job creation and destruction are highly correlated ($r = .59, p<.05$), bringing additional support for the claim that job creation and job destruction most likely are caused by the same factor – technological change.
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We expect positive relationship between the level of job creation and the level of voluntary mobility. We also expect positive relationship between the level of job destruction and the level of voluntary mobility. The same relationships we expect for the involuntary mobility of HQW. Job creation is an indicator for job opportunities. The level of job creation affects the voluntary mobility as it creates more room for employees to choose among jobs. It also affects positively the level of involuntary mobility as it generates opportunities for those who have lost their jobs to return back to the same industry. Job destruction may force some highly qualified workers to search for other jobs and may either result in better or worse match than the current one. Therefore, it may positively affect both, the voluntary and the involuntary movement of workers.

Shortages of HQW

Another phenomenon that is related to both, the evolutionary traits of an industry (such as the industrial growth), and to some more systemic facets of an economy (such as the responsiveness of educational institutions), is the level of HQW shortage. Demand shifts are often cited in the literature as a reason for temporary shortages of certain professions (e.g. Ryoo and Rosen 2004). Lack of certain qualifications comes about when the high demand for labour is faced with slow-responding educational institutions. During demand booms this can very likely be the case as it is well known that the short-run supply of highly qualified labour is not very elastic; the ‘production’ of new highly educated people responds with a four- to five-year lag due to necessary training periods. Moreover, in very new technological fields the educational platform supporting the production of adequate skills may even be absent.

Shortages of HQW may in short run increase the workers’ mobility due to several reasons, two of which we find appealing. In absence of effective work arrangements that reduce mobility (stock options, profit participation, non-compete agreements, fringe benefits) the personnel will flow from firms with less to firms with more attractive work agreements. Such situation was observed and widely explored in the Silicon Valley and the British Motor Valley where the engineers were repeatedly poached by competing firms by offering them more attractive work agreements. It took a while for the firms to learn how to effectively prevent the worker turnover in absence of legal enforceability of non-competes (Saxenian 1994).
A complementary way to argue about the direction of the relationship between the level of HQW shortage and their mobility is provided by Lewis and Yao (2003). These authors explain that scarcity increases the bargaining power of the employees to seek more open R&D environments. This means environments where they are more exposed to information and knowledge interchange with other firms and organizations. This exposure may additionally lead to formal and informal contacts and findings about potentially better quality matches and consecutively to higher voluntary mobility. Therefore, high demand and low supply of HQW should positively influence the level of voluntary mobility \textit{ceteris paribus}. The same direction of this relationship should exist for the involuntary mobility. Temporary shortages of HQW should create opportunities for reactivation of the workers who were previously forced into unemployment.

\textbf{III. Empirical Strategy}

\textbf{A. Data and methodology}

As a primary data source we use the weakly anonymous IAB Employment Sample (IABS), available for the period 1975 - 2004 and the weakly anonymous IAB Establishment History Panel (BHP), available for the period 1975 – 2005\textsuperscript{7}. From the available cross sections we only utilize the period 2000 -2004\textsuperscript{8}. The IABS contains information about the employment history of 2\% of the German population liable to social security. The BHP contains information about all establishments in Germany with at least one employee subject to social security, (starting 1999 also those with at least one marginally employed). We had an access to a 50\% sample of BHP population.

As argued above three digit industries are the most appropriate observational level for our purpose. Since the size of industries differs to a large degree in terms of both, the number of firms and the number of employees, some data issues have to be taken into account. Especially for some

\textsuperscript{7} Both datasets were accessed on-site at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB).

\textsuperscript{8} Utilizing the data prior to 1999 necessitates conversion of the NACE 93 and 03 codes to WZ 73 which, we suspect, may result in substantial inconsistencies.
very small industries the number of employees was not sufficient to compute meaningful intra-
industry mobility rates. Therefore, small industries have been merged in order to achieve a large
enough sample size that allows deriving trustable mobility rates. Collapsing industries was carried
out by preserving the closest distance with respect to the underlying labor inputs\textsuperscript{9}.

Dependent variables

Since the IABS reports the notifications to the social security on continuous, (daily) bases, one can
observe more than one change of the employment position in a given year. However, in order to
calculate the yearly mobility rates we took one point in time (June 30\textsuperscript{th}) each year and ignored
those spells of relatively short character that do not cover the chosen time point. Therefore, it
becomes important whether a person changed a job in a given year as compared to the previous
one and not how many times we see an occurrence of individual’s job changes in a given year.
Our dependent variable is then the count of intra-industry job-switchers between two years divided
by the total employment in the industry in the second year. We distinguish between voluntary and
involuntary mobility based on two criteria: the existence of unemployment or marginal
employment spell between two employments and the earnings levels. Involuntary mobile are those
workers who have experienced unemployment spell and/or earn less at the new job than at the
previous one. The first criterion is based on the belief that workers would not accept
unemployment state in presence of available employment opportunities. The second criterion can
be justified in several ways, two of which are in alliance with the theoretical reasoning offered
above: lower earnings indicate both, loss of human capital and lower-quality match, both
undesirable by workers. Each of these two criteria alone is sufficient to categorize a job move as
involuntary\textsuperscript{10}. We use nominal wages due to the phenomenon of real wages decrease in Germany
exactly in the time-period we are interested in\textsuperscript{11}.

\textsuperscript{9} The information on the aggregation of the small industries is available from the authors on request.
\textsuperscript{10} It is also empirically confirmed that the displaced workers (workers dismissed due to slack work, abolition of a
position or a shift, or closing or reallocation of a plant) earn significantly less at the new job as compared to
nondisplaced workers (Ruhm 1991).
\textsuperscript{11} Close inspection of the earnings’ behaviour of workers who retained a job within a firm in consecutive time-periods
showed that between 26.6\% and 40.2\% of the working population was affected by real wages decrease in the observed
time-frame.
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Two things are important to bear in mind when thinking about our definitions of voluntary and involuntary transitions. First, voluntary mobility may not always reflect the true intention of the worker to transit to another job on his/her own initiative. More explicitly, a move will be categorized as voluntary as long as the above described two criteria are fulfilled, although the true reason for transition may be a lay-off or abolishment of a job. Similarly, a quit will be categorized as involuntary if a person voluntarily transits to a job with lower pay. Although this confuses the conventional understanding of voluntary and involuntary move in sense of intentions, it does not contradict our argumentation about the different potential of knowledge transmission through voluntary and involuntary transitions. Second, the IABS earnings’ data is censored at an arbitrarily given censoring point. Around 12% of all observations of HQW are affected by this censoring and no imputation method can replicate the true earnings of this group accurately enough. This creates a doubt whether our sample of HQW reflects adequately the mobility behaviour of the group of HQW with highest earnings. To the extent possible we explored the mobility behaviour of the group of observations with earnings above the censoring point. This group was significantly less involuntary mobile (t = 8.4, p<.00) than the group of HQW observations who do not earn over the censoring point, but was not significantly different in terms of voluntary mobility. Here as a criterion for voluntary/involuntary movement we used the presence of unemployment/marginal employment spell between two employments. Therefore, at least in terms of voluntary mobility of “high-earners”, we do not find evidence for behavioural differences between these two income groups.

Independent variables

We use a rough indicator of the degree to which one industry is entrepreneurial, but we believe that this measure captures the most indicative feature of the regimes. As mentioned above, the crucial difference between these two regimes is that in the entrepreneurial one small and young firms have the innovative advantage, while in the routinized one large incumbents are more innovative. In our opinion this innovative advantage is well reflected in the R&D intensity indicators of small and large firms. Our indicator of the degree to which one industry is entrepreneurial is the share of workers with careers in occupations requiring a tertiary degree in
natural sciences or engineering in small firms (with fifty or less employees). The higher this share, the more entrepreneurial the industry is considered to be.

Our second independent variable is the turbulence. As we argued in the theory part, the turbulence is considered to be a consequence of technological change. We measure the level of turbulence through estimating the rates of job creation and job destruction. We obtain the sum of the change in the number of fully-employed workers in all establishments in a sector between two time periods and divide it by the size of the sector (number of fully employed workers at all establishments) at a second time period. Positive change in the number of fully employed workers enters the measure of job creation. Here we also include the employment in establishments that appear in the database for a first time. This indicates the job creation that is a result of start-ups. Negative change in the number of fully employed workers is associated with job destruction. This measure also encompasses the job closings of establishments that leave the database (our indication for firm exits).

To construct an indicator of the HQW shortage we use data on the average time it takes to fill up a position opening in given industry (vacancy time) as reported by the German Federal Employment Office (BA). We use the vacancy time of new job openings as an indicator of the mismatch between the demand and the supply of labour. Longer vacancy time of new job openings should indicate a more severe shortage of HQW.

Controls

We control for industry agglomeration effects, firm size and the industry concentration effects. To indicate the degree to which an industry is geographically concentrated, the gini measure of inequality is applied, as used by Krugman (1991). In order to control for firm size-related factors the median firm size is included. We avoid using the average firm size, as often used in the literature, because we observe right skewed firm size distributions within the industries. The Herfindahl index of concentration is used to measure the level of industry concentration. Instead

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12 We have also controlled for effects such as business cycle by adding year dummies, but they were insignificant for the overall and the voluntary mobility of HQW and did not affect the coefficient signs and significance of the variables of interest.
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of measuring the market shares in terms of output we measure them in terms of employment. Higher values for the Herfindahl index indicate that larger share of the employment in an industry is concentrated in few firms.

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<th>Table 1. Description of variables</th>
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<td><strong>Voluntary mobility</strong></td>
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<td><strong>Involuntary mobility</strong></td>
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<td><strong>Job creation</strong></td>
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<td><strong>Shortage</strong></td>
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<td><strong>Entrepreneurial regime</strong></td>
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B. Model specification

The most prominent way to deal with time-invariant unobserved heterogeneity across industries is a “fixed effects” (FE) model. Time invariant industry specific effects of mobility are in our example caused by industry specific human capital (compare Parent, 2000), industry specific capital, labor, knowledge demands, and other factors. Still one major drawback of FE models is that only the within variance is used while between variance is not taken into account. Since several industry characteristics that are important for explaining labor mobility are rarely changing over time several problems occur when unit fixed effects are present. Industry specific effects like geographical concentration, industry concentration and technological regime show very little variation over time so that the FE model performs poorly in estimating the effect of these variables. Furthermore, a basic FE model does not allow estimating time-invariant variables at all. One possibility to deal with rarely changing variables in a fixed effects setting is a fixed effects vector decomposition model (Plümper and Troeger, 2007). The procedure is as follows: first a fixed effects model is estimated with all our variables of interest; second, the unit fixed effects of this model are decomposed into a part that can be explained by the time-invariant and rarely changing variables and a part that cannot be explained by these variables by using pooled OLS; and third, the initial model is re-estimated by including the part of the unit fixed effect that cannot be explained by the time-invariant and rarely changing variables. Based on Monte Carlo simulations, Plümper and Troeger show that the vector decomposition method performs more efficiently than the FE model, especially for those independent variables where the ratio of within and between variance is large (Plümper and Troeger, 2007).

The estimated model has the following form

\[
\text{mobility}_{i,t} = \frac{\sum \text{employees}_{i,j, t-1 \neq j, t=0}}{\sum \text{employment}_{i,t=0}} = \beta_0 + \beta_1 X_{i,t} + \beta_2 Z_{i,t} + \nu_{i,t} + \xi_{i,t},
\]

where \(\text{mobility}_{i,t}\) is the mobility rate, defined as the number of employees in industry \(i\) that work in \(t=0\) in firm \(j\) and in \(t-1\) in another firm divided by the total employment in industry \(i\). \(X\) is a
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vector of industry specific variables considered as time variant and $Z$ is a vector of variables considered as rather time invariant. Since almost all independent variables are skewed we use log-transformations.

C. Results

Descriptive Statistics

Highly qualified workers are significantly more voluntary mobile than non-HQW, ($t = 3.31$, $p<.001$) and significantly less involuntary mobile than the non-HQW, ($t = -4.11$, $p<.000$). Both findings are in line with our expectations. Between 12.9% and 16.9% of the HQW population in Germany is being reshuffled annually in the period 2000-2004, which is surprisingly high. When it comes to the HQW mobility within 3-digit industries, the average annual mobility rates move between 3.6% and 4.4%. Looking at the voluntary mobility rates of HQW within industries, between 2.4% and 3.2% of all HQW change their jobs annually within 3-digit industries.

With respect to mobility of HQW we find that the largest share of general mobility of HQW can be tracked back to voluntary mobility during the period of investigation. This is true for overall job-to-job mobility as well as for intra-industry mobility. As the correlation table in the appendix shows, general and voluntary intra-industry mobility are correlated to a higher degree, ($r = .89$, $p<.001$), than overall and involuntary intra-industry mobility, ($r = .65$, $p<.001$). The observed correlation between voluntary and involuntary mobility is about 0.23 ($p<.001$). It may also be interesting to get a feeling for the change of the mean mobility rates over time. Figure 1 and Figure 2 show the average mobility levels of HQW for the general economy (Figure 1) and within the industries (Figure 2).

Although we did not yet make any trend estimations, it seems that the voluntary HQW mobility is pro-cyclical and involuntary counter-cyclical, as usually argued in the labour economics literature. Some of the industries with highest overall mobility of HQW are NACE 321 (Manufacturing of electronic components), NACE 401 (Electricity providers), NACE 601 (Railways), NACE 642 (Broadcasting), and NACE 725 (Maintenance and repair of office machines and PCs).
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Figure 1 Overall job-to-job mobility of highly qualified workers and the unemployment rate
Source: IAB Employment Sample (1975-2004), own calculations

Figure 2 Intra-industry job-to-job mobility of highly qualified workers and the unemployment rate
Source: IAB Employment Sample (1975-2004), own calculations
Regression results

Table 2 presents the regression results for general, voluntary and involuntary mobility of HQW\textsuperscript{13}. The regression results indicate that job destruction – a direct consequence of technological change – increases all different types of mobility that are distinguished in this analysis. Despite that, job creation has no significant impact on general and voluntary mobility of highly qualified workers. For involuntary mobility turbulence appearing as job creation has a negative impact while job destruction increases involuntary mobility. These results indicate that downsizing in an industry increases involuntary mobility (involuntary shift of workers) while expansions reduce it.

Our measure of shortage did not show any significant impact on mobility in the models. It might be the case that those businesses that employ the workers are able to keep their employees although the shortage of labor supply shifts bargaining power to the employees. This might be realized by increased wages, better working conditions and various fringe benefits. Since both, the firm and the potential mover know that a match separation implies search and adaptation costs, firms, aware of the shift in the bargaining power, may be willing to renegotiate wages to the point where their marginal increase equals the marginal cost imposed by search and adaptation costs.

Entrepreneurial regime, which captures the importance of small businesses for the industries’ innovative activities, has a significantly positive impact on voluntary HQW mobility. This result indicates that low concentration of innovation, large number of innovators and high rates of entry create conditions that increase voluntary mobility of highly qualified workers.

Our controls work fine most of the time. The geographical concentration affects positively all types of mobility. This was expected as geographical distance incurs moving costs. The more an industry is geographically concentrated the lower are the moving costs of transiting to another job.

\textsuperscript{13} As job creation and job destruction are highly correlated, we suspected potential collinearity problem and therefore estimated models that include only one of our turbulence measures. The set of models including only job destruction is nearly identical with the set of models presented in Table 2. These estimations are available from the authors on request.
Table 2. Determinants of the mobility of highly qualified workers

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<tr>
<th></th>
<th>Model I</th>
<th>Model II</th>
<th>Model III</th>
<th>Model IV</th>
<th>Model V</th>
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<th>Model VII</th>
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<td>Overall Mobility</td>
<td>-0.333</td>
<td>0.174</td>
<td>-0.508**</td>
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<td>0.171</td>
<td>0.295**</td>
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<td>Industry share of highly qualified workers</td>
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Panel fixed effects regression with vector decomposition.
Panel corrected standard errors in parentheses. Significant at + 10%, * 5%, **1%.
All independent variables in log form.
The coefficients for the median firm size are significant and negative for all our dependent variables. In industries where the firms tend to have larger size the internal labour markets dominate the external labour markets. Large firms can accommodate much better the needs for change and promotion of the workers and therefore the within-firm movement replaces the between-firm movement of workers. Additionally, large firms can often offer more generous fringe benefits, efficiency wages and in general higher returns on tenure, all of which disincentivize the separations of the employees from the firm. The interaction term between geographical concentration and median firm size is also negative for all our dependent variables indicating that the positive effect that geographical concentration has on mobility is lower in industries with larger median firm size. Finally, while the industry concentration has the expected negative effect on involuntary mobility, it has a positive one on voluntary mobility. This positive effect of industry concentration on voluntary mobility has an unexpected sign which is somewhat puzzling for us.

IV. Conclusion

This study combines existing knowledge in a way which provides a novel approach in the empirical investigation of workers’ mobility relevant for knowledge transmission. An analysis of the patterns of intra- and inter-industry voluntary and involuntary mobility helps us in obtaining a closer picture of the potential for knowledge transmission through labour mobility in the German industries. We propose that solely looking at the general mobility of HQW in an economy may not be an appropriate framework for analysing the potential for knowledge transmission. The potential for knowledge dissemination through labour mobility may be lower than what we observe at first glance if we agree that actors from different industries may experience difficulties in communicating ideas due to their cognitive distance. If we further agree that voluntary mobility is more likely to result in knowledge dissemination than involuntary mobility, the potential for knowledge spillovers through labour mobility decreases even further as seen by the results presented earlier. Therefore, reports that look at the general mobility of HQW without considering industry borders and reasons for mobility may overestimate the importance of this channel of knowledge transmission. However, it is difficult to say whether the intra-industry mobility level
we observe in the German data is beyond or below the optimal before conducting a study that looks at the relationship of the mobility level and industrial progress. Moreover, in absence of comparative studies for other countries, it is not possible to compare the mobility levels around similar technologies (within same industries). These are calls for further research.

This study provides insights in how industry-specific factors shape the patterns of mobility through influencing the level of industry turbulence and demand for HQW. We find that the level of turbulence measured through job destruction positively influences both the voluntary and the involuntary mobility of HQW, while job creation has a negative effect on the involuntary mobility. Highly qualified workers are both, more voluntary and involuntary mobile in the entrepreneurial regime.

Obviously certain sector-, technology-, and evolution- specific factors affect the level of job-to-job mobility of HQW. This means that depending on these factors, mobility, as a channel of knowledge transmission may be of lower or higher significance for different sectors. For example, sectors in a routinized regime should not rely much on mobility as a channel of knowledge diffusion. Rather than this, firms in such sectors should focus on nurturing or establishing other ways of communicating knowledge, as for example open research environments and different forms of R&D cooperation. More direct policy implications in terms of institutional arrangements cannot be concluded based on this or any similar study that focuses on a single country because institutions are often constant within sectors of one country. However, repeating the design of mobility measurement of this study by using the social security data available in different European countries may enable a comparative institutional research with direct policy implications.
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## Appendix

### Correlations

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*Significant at 5%

All variables except mobilities are in log-form