

SPATIAL SIMULATION OF JOB LOCATION MOBILITY OF HIGHLY QUALIFIED EMPLOYEES IN MAINFRANKEN

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With 5 figures and 4 tables

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Summary: Affected by changing frame conditions of gainful occupation, employees are facing a growing need to be geographically mobile on the labour market. Although the knowledge intensification of the overall economy is progressing, the demand for high-skilled human capital is regionally selective. This paper deals with the inner German job location mobility of academics and occupationally highly qualified employees, who had been working in Mainfranken between 1999 and 2008. In a first step, the job location mobility for both types of highly skilled employees will be explored by analysing their labour market biographies. In a second step, those findings will be used to develop a modelling approach, which simulates the supra-region mobility of Mainfranken's highly qualified employees on an individual level. The model is a two-step approach using age group-specific mobility rates to determine how many highly qualified employees changed their job location in a twelve-month period. Next, and based on the utility theory, allocation and matching processes for academics are simulated in a Monte Carlo simulation. Simulation outputs will be presented through the example of academics.

Zusammenfassung: Unter Einfluss sich wandelnder Rahmenbedingungen der Erwerbsarbeit steigt für Arbeitnehmer die Notwendigkeit der räumlichen Mobilität am Arbeitsmarkt. Für hochqualifizierte Arbeitskräfte gilt dies in besonderem Maße, denn trotz der zunehmenden Wissensintensivierung der Wirtschaft verläuft die Nachfrage nach hochqualifiziertem Humankapital räumlich selektiv. Dieser Beitrag widmet sich den räumlichen Arbeitsortwechslern (Arbeitsortmobilität) von akademisch und beruflich hochqualifizierten Personen, die zwischen 1999 und 2008 in Mainfranken beschäftigt waren. Zunächst soll das Mobilitätshandeln der Untersuchungsgruppen über eine Analyse von erwerbsbiographischen Daten näher spezifiziert werden. Befunde werden anschließend zur Erstellung eines Modellierungsansatzes auf Mikroebene verwendet, der in der Lage ist, die überregionale Arbeitsortmobilität von in Mainfranken beschäftigten Hochqualifizierten zu simulieren. In zwei Stufen ermittelt das Modell zunächst die Anzahl an Beschäftigtenabgängen eines Arbeitsortes innerhalb eines Jahres und stellt anschließend unter Verwendung der Nutzentheorie und einer Monte Carlo-Simulation den Allocations- und Matchingprozess nach. Simulationsergebnisse werden dabei am Beispiel von akademisch Hochqualifizierten präsentiert.

Keywords: Mobility, labour market, Mainfranken, spatial simulation, utility theory, Monte Carlo simulation, highly qualified employees

1 Background

Spatial mobility between labour markets is not just a side effect of employees' and employers' searching processes – it is often the basic precondition for workers entering into an employment relationship (FRANZ 2009, 197ff.). Moreover, labour mobility also impacts knowledge diffusion and contributes to regional knowledge formation, it affects the performance of companies and is the basis for the economic success of regions (BOSCHMA et al. 2009, 169). Adverse working conditions – such as high risk of becoming unemployed, the prospect of low income, status or dissatisfactory job content – can motivate employees to leave regional labour markets and thus lead to a restructuring of employment systems (SOLGA et al. 2000, 242ff.).

Globalisation and the growing importance of labour market flexibility, the sectorial transition of economy as well as technical changes increase the individual necessity of spatial and social mobility (BLOSSFELD et al. 2008, 23). Empirical findings for Germany show that job mobility between firms more and more is accompanied by regional mobility (HAAS 2000, 4). Although the knowledge intensification of the economy is continuously progressing and highly qualified employees more than ever are becoming an important resource for innovation and regional development (MÖSGEN 2008, 54), the increasing labour market flexibility (ALBRECHT 2005, 14ff.) and the regional selectivity of the demand for highly qualified human capital (MEUSBURGER 1998, 378f.) lead to an increase in the need for individuals to be mobile. In particular academics tend to

change their place of work more frequently when taking up a new position than workers with a lower qualification (HAAS 2000, 6). Comparing this development with other geographical studies two general deficits can be identified and are presented in the following paragraphs.

The first deficit is that changes of residences typically are the main focus when researching the spatial mobility of highly qualified persons in geographical studies (e.g. FASSMANN and MÜNZ 2004; MATUSCHEWSKI 2010; KLEIN-HITPASS 2011; FÖBKER et al. 2014; SHINOZAKI 2014). The increasing importance of commuting (HAAS and HAMANN 2008; WREDE 2013) or work-related multilocality (WEICHHART 2009; PETZOLD 2013, 33ff.) applies especially to highly qualified employees. Hence, when analyzing job location changes (with or without change of residence) more expedient insights into regional and economic developments can be won than when analyzing residential changes. Job location mobility therefore is defined as taking up a new job at a spatial unit different from the former one and thus follows the concept of actually realised mobility (HAMMER and SCHEINER 2006, 18f.; KOHL 2014, 27). Depending on the underlying scientific question, these spatial units can be predefined as communities, districts, regions etc. This paper focuses on job location mobility between German districts and urban communes, a definition that is also used by DAMELANG (2007, 12) and it examines job location mobility independently from changing residences or whole companies moving. If a person holds more than one job, only the main job, defined as the occupation with the highest salary, is considered in the study. Different from DAMELANG (2007), job location mobility is also distinguished in relation to a spatial unit on a higher aggregation level (here the study area of Mainfranken in Bayern (see Chapt. 2): *intraregional job location mobility* describes mobility cases within the study area. Consequently the process of leaving or entering the study area is termed as *interregional job location mobility* with one particular area as the source or destination of the respective mobility flow.

A second deficit found is the use of the term “highly qualified persons”. Frequently the term only takes academics into consideration (e.g. KLEIN-HITPASS 2011; RHEIN and STÜBER 2014). However, educational and classification systems follow another definition: The German educational system, for instance, understands tertiary education as “high qualification”. This includes graduates from academic institutions (e.g. universities) as well as

graduates from tertiary occupational institutions (e.g. professional schools; MISCHKE 2013, 394f.). Other classification systems such as UNESCO’s *International Standard Classification of Education*, ILO’s *International Standard Classification of Occupation* and the BA’s *classification of occupations* consider academic education and tertiary occupational qualifications as “high” (UNESCO 2012, 46ff.; ILO 2012, 11ff.; PAULUS and MATTHES 2013, 9ff.). In the past, missing information on occupational high qualifications in secondary statistics has been the reason for a lack of precision in scientific studies. Only in 2012 the German Federal Employment Agency (BA) started distinguishing between academic and occupational high qualification in German employment statistics (BA 2012, 4). This paper follows a differentiated understanding of highly qualified persons and therefore describes job location mobility of academics and occupationally highly qualified employees (OHQEs) separately.

Given the two described deficits, one aim of this paper is to gain insights into the job location mobility of highly qualified employees, who worked in the study area at least temporarily. For this purpose, statistical data of the Institute of Employment Research (IAB; research Institute of the BA) will be analysed (see Chapt. 2). It is important for municipalities to detect emerging bottlenecks in their labour market resulting from highly qualified employees’ job location mobility at an early stage in order to prevail in the “global competition for investment, talent and jobs” (FÖBKER et al. 2014, 544). A forecast model estimating future job location mobility could be of valuable service in achieving that goal. Although the prognosis of individual mobility behaviour is quite complex, it is possible to use the analytical findings to generate a model on a low aggregated scale, which in turns allows estimating future developments based on specific assumptions. Even though the available data offers sound information on individual job location mobility, the data are taken from a random sample and drawing overall conclusions on the job-related spatial mobility of highly qualified employees is not permissible. However, and this is the second aim of this paper, it is possible to model and to simulate the spatial mobility of whole segments of labour markets in a satisfactory quality. The methodology of this paper differs from other studies, which use multivariate analysis to acquire knowledge of spatial mobility between labour markets (DAMELANG 2007; NISIC 2012; SCHNEIDER 2011; WINDZIO 2004 and 2007) or predict future developments (FUCHS et al. 2011)

but they do not consider the socio-demographic and work-related framework conditions of employees after their switch between locations of workplaces. Spatial simulation in general can neither be fully attributed to the inductive nor deductive methods, but instead has to be understood as a third way to obtain knowledge (RAUH et al. 2008, 77). By using the model different scenarios can be simulated, e.g. to predict future developments, which in turn are useful when answering different political or planning-relevant questions (SCHENK 2008, 48).

2 Data and study area

The Institute of Employment Research's (IAB) *Sample of Integrated Labour Market Biographies – Regional File 1975-2008* (SIAB-R 7508) includes anonymous data for about 1.5 million individuals. It is a 2% random sample of *Integrated Employment Biographies* (IEB), another IAB data product and consists of employment biographies of persons who were subject to social security between 1975 and 2008, who were marginal part-time employees or who purchased services in accordance with Social Code Book II or III. Registered jobseekers or participants in an employment or training measure are also included into the dataset. Organised in longitudinal data, the sample includes depicted to the day information for white- or blue-collar workers and trainees. Civil servants, self-employed workers and regular students are not recorded as they are exempted from social security contributions (see DORNER et al. 2011, 6ff.).

SIAB-R 7508 covers 26 variables and the data are suited for the analysis of the personal and work-

related conditions in which job location mobility takes place (DORNER et al. 2011, 30ff.). By mapping the sample with secondary statistical indicators it is possible to analyse the structure of source and destination areas of job location mobility (e.g. the local economy, demography or living conditions).

Although SIAB-R 7508 offers a broad range of information, some restrictions apply. In order to prevent de-anonymisation, some job location variables were aggregated by joining district regions in the study area together, namely districts and urban communes with a population of less than 100,000 inhabitants are combined to district regions (DORNER et al. 2011, 43). Some districts in the study area are also pooled, leading to more imprecise spatial analyses of the intraregional job location mobility in parts. Interregional mobility, however, can be fully displayed. Another restriction is that information on personal motives, intentions or social networks influencing the decision to seek a new employer or to choose another job are also not contained in the data.

Furthermore SIAB-R 7508 only offers direct information on academic tertiary qualification. In order to analyse job location mobility of OHQEs, an own operationalisation method had to be developed. The quality of this operationalisation can be checked by comparing the average daily gross wages of academics, OHQEs and vocational workers. The qualification-related income disparities (Tab. 1) become apparent and seem to be realistic (see also SEYNSTAHL 2015b, 101ff.).

The study area Mainfranken is located relatively central in Germany and in the north-western part of Bayern (Fig. 1). The geographical position proves to be very suitable for both the analysis and the sim-

Tab. 1: Disparities of average daily gross wages between qualification levels in full-time jobs of employees subject to social insurance contributions in Mainfranken, 1999–2008

Level of qualification	Number of job episodes examined	Average daily gross wage	Extra income compared to next lower level of qualification	
			absolute	relative
Academics	7,318	108.77 €	+ 25.52 €	+ 31 %
OHQEs	2,415	83.25 €	+ 15.77 €	+ 23 %
Vocational workers	70,271	67.48 €	-	-

Source: SIAB-R 7508, own calculations



Fig. 1: The study area of Mainfranken and its location within Germany

ulation. Because SIAB-R 7508 only provides information on employments within Germany, selecting the Mainfranken area limits the number of subjects crossing international borders when switching firms. Besides this advantage the study area can be described as a demographically and economically heterogeneous region with economical competences in the fields of mechanical engineering and automotive, healthcare, the food industry as well as the cross-sectional technology “new materials”. A leading branch does not exist (SEYNSTAHL 2015b, 83f.). According to the latest official population projection (LStDV BAYERN 2014), Mainfranken’s future economic development will be affected heavily by demographic change, which manifests in an aging and – especially in the northern and eastern districts – declining population (ibid., 10). According to estimations of the Chamber of Commerce and Industry fulfilling the demand for highly qualified

employees will be influenced negatively by demographic change (see KAGERBAUER 2012, 37).

3 Empirical findings

3.1 Mobility cases and rates

The analysis of job location mobility is concentrated on the last ten years of SIAB-R 7508 (1999 to 2008) as there are only small changes of the employment notification procedure within this period (DORNER et al. 2011, 27 and 40). The analysis data include 1,208 employment biographies of academics and of 355 OHQEs, who had been employed in the study area between 1999 and 2008 for at least one day. During this time 1,417 cases of job location mobility are registered, 1,130 of them realised by academics and 287 by OHQEs. The findings re-

veal that job location mobility increased the study area's stock of highly qualified employees since more people entered than left the Mainfranken labour market regardless of which group they belong to. The two groups, however, differ in regards to the extent of intraregional job location mobility. While only 20% of the mobility cases in the sample of academics took place within Mainfranken, 33% of the OHQEs changed job locations.

Mobility rates, defined as the percentage of persons in a sample group that realised an inter- or intraregional job location mobility during the investigated period, give a more specific impression of the examined groups' job location mobility. 64% of the academics and 49% of the OHQEs changed their job locations during the investigated period. This suggests that there is a higher general willingness – or need – for academics to be geographically mobile. 50% of the academics and 70% of the OHQEs changed their job location intraregionally or not at all. This result can be compared to a finding by HOLSTE (2010), who determined that 61% of all employee recruitment within Mainfranken is realized within the area (*ibid.*, 121f. and 171f.). The lower general mobility rate as well as a higher rate of intraregional job location mobility (19% OHQEs against 14% for academics) in the OHQE group can be interpreted as a stronger tie to the Mainfranken region. This hypothesis is supported by additional analyses of spatial patterns of their job location mobility (see 3.2).

As shown for both groups, interregional job location mobility occurs more often than intraregional changes and the number of persons entering the Mainfranken area reaches a higher share than those leaving the area (Tab. 2). However, it is also important to emphasise that not every inflow to the Mainfranken labour market is permanent: between 1999 and 2008 16% of the academics and 11% of the OHQEs took up a job in Mainfranken but later on left the work place to work in a Non-Mainfranken firm.

Only 23% of the academics and 21% of the OHQEs changed their job location during the ten-year investigation period more than once. In both groups there is a high affinity towards one specific type of job location mobility: 72% of multi-mobile academics respectively 47% of the multi-mobile OHQEs only switch job locations interregionally, while another 13% (academics) respectively 17% (OHQEs) only switch intraregionally. This explains why just 3% of the academics and 8% of the OHQEs between 1999 and 2008 change firms intra- and interregionally (Tab. 2).

3.2 Spatial patterns

The majority of the source and destination areas of interregional Mainfranken-related job location mobility can be found in Germany's south

Tab. 2: Mobility rates of Mainfranken-related job location mobility between 1999 and 2008

	Academics	OHQEs
Mobile persons in total	773 (64%)	174 (49%)
Interregionally mobile persons (total)	642 (53%)	132 (37%)
...with Mainfranken as the source area	329 (27%)	75 (21%)
...with Mainfranken as the destination area	531 (44%)	100 (28%)
Intraregionally mobile persons	173 (14%)	69 (19%)
Inter- und intraregionally mobile persons	42 (3%)	27 (8%)
Immobile persons in total	435 (36%)	181 (51%)
Number of all employees (n)	1,208 (100%)	355 (100%)

Source: SIAB-R 7508, own calculations

Tab. 3: Source and destination areas of interregional Mainfranken-related job location mobility between 1999 and 2008 on the level of German federal states

	Inflow source areas		Outflow destination areas	
	Academics	OHQEs	Academics	OHQEs
Bayern	34.5%	46.8%	37.4%	45.8%
Baden-Wuerttemberg	15.6%	15.6%	12.2%	13.3%
Hessen	12.6%	10.1%	11.3%	18.1%
Nordrhein-Westfalen	11.5%	8.3%	13.0%	6.0%
Niedersachsen	5.4%	1.8%	6.7%	0.0%
Thüringen	4.1%	5.5%	3.8%	6.0%
Sachsen	3.4%	4.6%	4.3%	3.6%
Rheinland-Pfalz	2.9%	0.9%	1.4%	1.2%
Berlin	2.9%	0.9%	3.8%	2.4%
Hamburg	1.6%	0.9%	2.6%	2.4%
Sachsen-Anhalt	1.3%	0.9%	0.3%	1.2%
Schleswig-Holstein	1.1%	0.9%	0.9%	0.0%
Brandenburg	0.9%	1.8%	0.6%	0.0%
Bremen	0.7%	0.9%	0.9%	0.0%
Saarland	0.9%	0.0%	0.6%	0.0%
Mecklenburg-Vorpommern	0.5%	0.0%	0.3%	0.0%
n	556	109	345	83

Source: SIAB-R 7508, own calculations

(especially Bayern and Baden-Württemberg), Hessen and Nordrhein-Westfalen. Eastern and northern Germany, Rheinland-Pfalz and Saarland are less important (Tab. 3). Major differences between the two sample groups can be described on a regional scale: A high proportion of the OHQEs change their job locations to areas neighbouring the study area (41% of incoming and 40% of outgoing flows). Among academics the percentage reaches 20% (incoming flows) respectively 17% (outgoing flows).

Due to the described mobility patterns the average distance between sources and destinations of interregional job location mobility in both sample groups differ: for academics the inflow source areas to the labour market show a mean distance of 179 km from Mainfranken; the mean outflow distance is 188 km. Mean distances for OHQEs are shorter with inflows of 141 km and outflows of 128 km.

By using a settlement classification of the BBSR (2009) the hierarchy of source and destination areas of Mainfranken-related interregional job location mobility within the settlement system is depicted in figure 2. The labour markets of core cities and their densely populated surroundings are of high importance for company changing academics. München, Nürnberg/Erlangen, Berlin, Hannover, Frankfurt, Düsseldorf, Stuttgart, Köln and Hamburg are major source or destination areas for their interregional job location mobility. In many cases OHQEs also take up jobs in core cities and their densely populated surroundings. That notwithstanding, rural surroundings and rural areas reach higher shares than those in the academics' sample. Important source and destination areas for OHQEs' interregional job location mobility are Frankfurt, Nürnberg, Düsseldorf, München, Hamburg and Berlin.

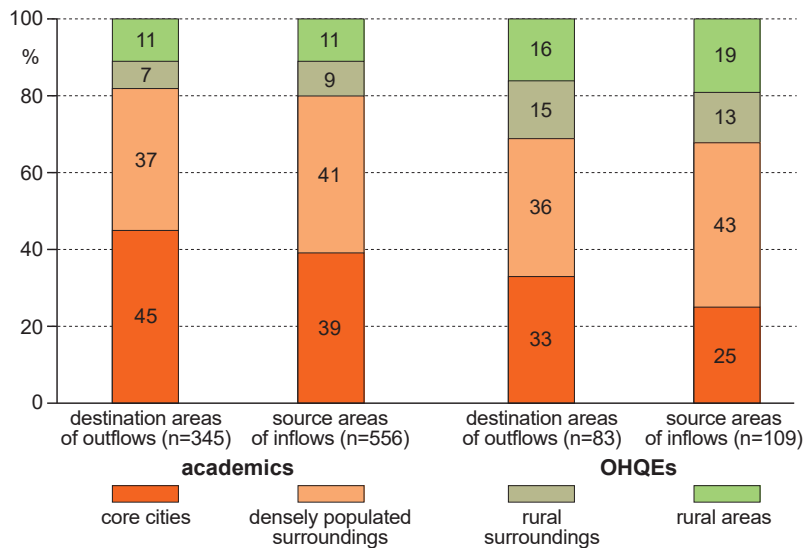


Fig. 2: Structure of destination and source areas of Mainfranken-related job location mobility between 1999 and 2008 based on the BBSR 2009 settlement classification. Source: SIAB-R 7508, own calculations

4 Spatial simulation of academics' inter-regional job location mobility with Mainfranken as source area

4.1 Concept and quality of the model

In this chapter a modelling approach to simulate job location mobility will be outlined. The model firstly aims to estimate the total number and demographic structure of employees leaving the Mainfranken labour market in a specific year and secondly, to simulate the spatial mobility of these employees. The approach offers not only the opportunity to simulate the mobility of those individuals represented in the SIAB-R 7508 dataset but for the whole segment of highly qualified persons who work in a specific labour market region. There is, however, one restriction since the official statistics do not offer information on the total number of OHQEs working in Mainfranken between 1999 and 2008 (scenario I)¹⁾, which is important for forming a starting population for the simulation. Hence, the model concentrates on academics and furthermore on their interregional job location mobility with Mainfranken serving as the source area. However, it should be stressed that the concept of the model per se is not restricted to only one type of job location

mobility. Depending on appropriate data it can also be used to simulate all types of job location mobility.

The modelling is carried out in two steps (see Fig. 3) and starts with estimating the number of all employees who will leave their job location during a given year. SIAB-R 7508 contains the numbers of employees and mobility cases of each given year and they can be used to calculate mobility rates. The dataset also allows differentiating those rates by age. Four age groups were distinguished: employees under the age of 30, between 30 and under 40, between 40 and under 50, and those 50 years and older. Employees younger than 20 and older than 60 years were not included since their number of mobility cases is low. Multiplying these mobility rates by the total number of academics working in the Mainfranken district regions in a given year, the number of all labour market outflows can be calculated. To uncover the demographic structure of the mobile employees this procedure is separately repeated for each of the four age groups and for every district region within Mainfranken.

During the second step of the model the mobile employees are individually allocated to their new job location. First utility values ($U_{a,D}$) for each possible destination are calculated separately for every age group. These values are used to evaluate potential new job locations outside of Mainfranken. One important component influencing the utility of a job location is formed by combining seven regional development indicators. On the one hand they indicate the job location attractiveness and on the other hand

¹⁾ The basic scenario I is used for calibration and optimisation of the model by comparing simulation outputs with empirical data. In accordance with the empirical analysis of the SIAB-R 7508 data it covers the decade from 1999 to 2008.

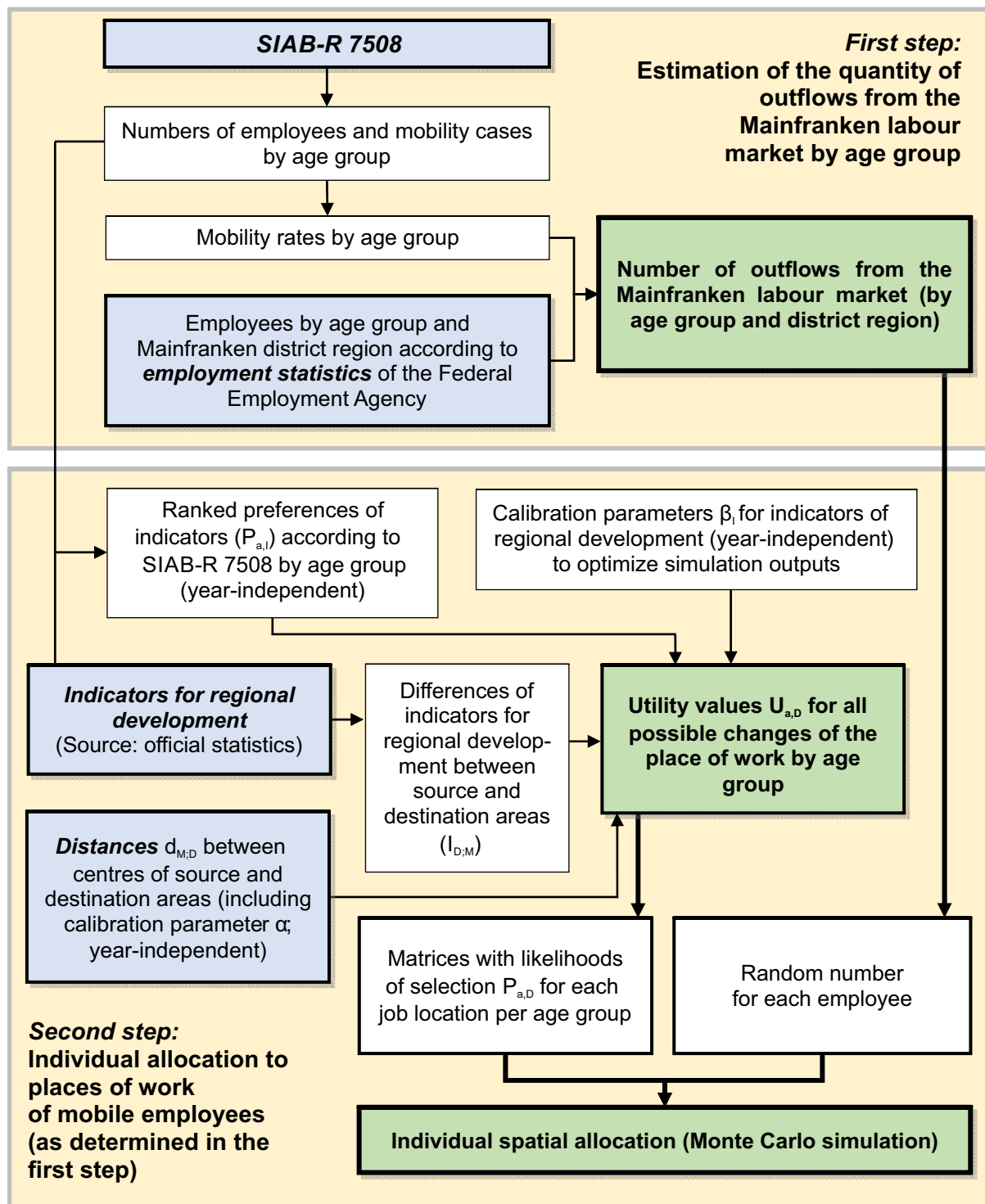


Fig. 3: Concept of the two-step model for job location mobility for one year

they show the demand for workforce respectively for academically educated employees. Previous analysis showed that depending on the age group there are

great disparities in respect to the structure of the favoured destination areas in comparison to the respective source areas. Hence, for all regional devel-

opment indicators differences between source and all potential destination areas are calculated ($I_{D;M}$). The differences are calculated for the following indicators: number of employees who are subject to social insurance contributions, percentage of academics by the number of employees, gross domestic product per employed person, annual mean rate of unemployment, income of private households per inhabitant as well as prices for building land and housing stock per inhabitant. Aside from these differences, $U_{a,D}$ also depend on the distances between the centres of the source and destination areas, age group-specific and year-independent ranked preferences of the structure of potential destination in comparison to source areas and calibration parameters to optimise simulation outputs (also see SEYNSTAHL 2015b, 169ff):

$$U_{a,D} = \frac{1}{d_{M;D}^\alpha} \sum_w P_{a,I} \cdot I_{D;M} \cdot \beta_I \quad (\text{eq. 1})$$

with: $U_{a,D}$: Utility value of a switching to a different job location D for an employee in age group a ; $d_{M;D}$: distance between the last Mainfranken job location M and D ; α : calibration parameter for $d_{M;D}$; $P_{a,I}$: preference of age group a regarding indicator I 's difference between destination (D) and source area (M); $I_{D;M}$: difference of indicator I between destination (I_D) and source (I_M) in the simulated year n ($I_{D;M} = I_D - I_M$); β_I : calibration parameter for $I_{D;M}$.

The single utility values $U_{a,D}$ can be interpreted as the probability that a mobile employee in age group a may accept a job offer in destination area D (RAUH et al. 2012, 15):

$$P_{a,D} = \frac{U_{a,D}}{\sum U_{a,D}} \quad (\text{eq. 2})$$

with: $P_{a,D}$: Likelihood that an employee in age group a takes up a job in destination area D ; $U_{a,D}$: Utility value of a job location switch to D for an employee in age group a .

To simulate job location mobility, the calculated likelihoods of selection are transferred into a Monte Carlo simulation. As early as 1968, the principle was performed in HÄGERSTRAND's spatial model of innovation diffusion (HÄGERSTRAND 1968): by cumulating all $P_{a,D}$ every possible destination area is attributed to an interval that matches with the probability of the utility value's occurrence. With reference to HÄGERSTRAND's *Mean Information Field* the matrix containing these intervals is referred to as *Mean Job Field* (MJF). Different to HÄGERSTRAND, several time steps are not simulated in one MJF but an own MJF is created for every simulated year, every age group as well as for every Mainfranken source area. The

spatial allocation of employees, who were identified as being "interregionally mobile" in the model's first step, is simulated by drawing a random number. This way the interval of a possible destination region is marked which in turn is interpreted as the final spatial allocation of the individual employee. The model was created in Microsoft Excel. Other programmes can also be used, as long as they are able to combine data sets in formulas via hyperlinks and process "if functions".

Using the calibration parameters α and β_I of equation 1 it is possible to minimise differences between the empirical data (SIAB-R 7508) and the simulation output. To measure the quality of single simulation runs while testing different calibration parameters, the relative quadratic deviation of estimated outputs versus empirical data as presented by RAUH et al. (2012, 17) is used. This leads to comparing the demographic structure of the four age groups to five destination areas types, namely core cities, densely populated surroundings, rural surroundings, rural areas and neighbouring district regions:

$$R^2 = 1 - \left[\frac{\sum_T (a_{est,T} - a_{emp,T})^2}{\sum_T a_{est,T}^2} \right] \quad (\text{eq. 3})$$

with: R^2 : goodness-of-fit measure; $a_{est,T}$: percentage of age group a in destination area type T estimated by the model; $a_{emp,T}$: percentage of age group a in destination area type T according to empirical data.

As Monte Carlo simulations follow the law of large numbers it is reasonable to repeat simulation runs several times in order to achieve more reliable results. For this reason every calibration parameter is tested in 100 iterations. The mean goodness-of-fit measures of all simulation runs can be used to evaluate the quality of the model. After optimisation the final model reaches high levels of mean goodness-of-fit measures in the different destination area types. Especially in core cities ($R^2 = 0.99$) and densely populated surroundings ($R^2 = 0.98$) the demographic structure of the model almost exactly corresponds with the empirical data. Also in rural areas ($R^2 = 0.82$) and neighbouring district regions ($R^2 = 0.94$) the goodness-of-fit measures can be described as satisfying. The lowest value of 0.60 is achieved for rural areas, but even this R^2 attests a good quality of the model. The cartographic illustration also shows that spatial patterns of the empirical data can be reproduced by the model rather well (see Fig. 4): the shares of the larger cities as destination areas of academics leaving a Mainfranken job location are similar. Furthermore, the percentage of former Mainfranken workers taking up a new job in a location neighbour-

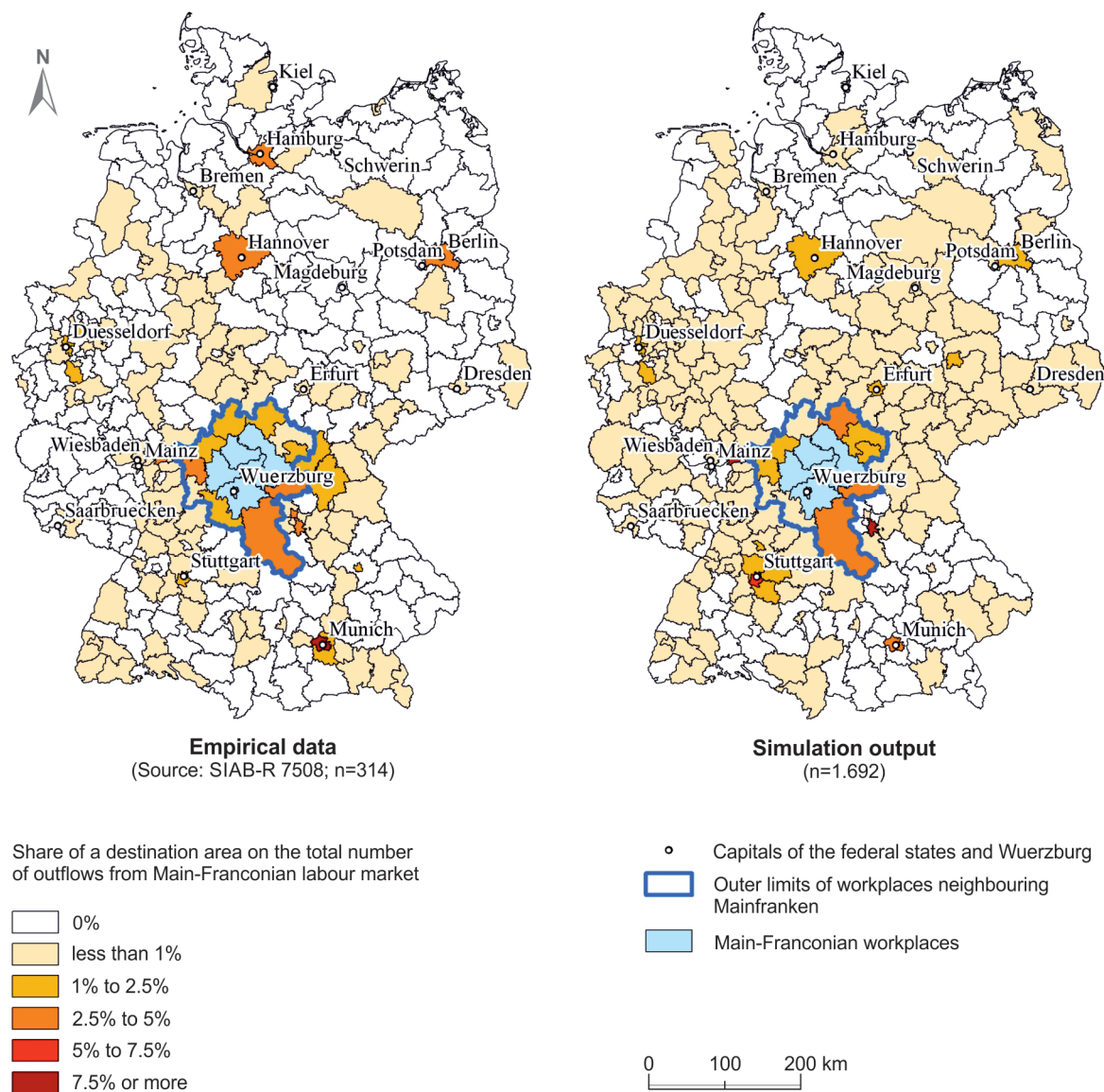


Fig. 4: Comparing empirical data of academics leaving Mainfranken job locations to the results of one simulation run. Source: SIAB-R 7508 and own simulation results

ing the study area in both maps is comparable (17% outflows in the empirical data respectively 16% simulated job location changes).

4.2 Simulation of outflows from the Mainfranken labour market 2009 to 2018

Long-term simulations of future free-market processes are arguable because wages and prices as well as the supply and demand for labour develop quite dynamically and therefore are hard to estimate

with a satisfying significance (BA 2011, 7). To avoid high deviations, only the prospective outflows of academics leaving the Mainfranken labour market during the ten-year period from 2009 to 2018 are simulated. The assumption is that long term development trends of the different variables used in the model between 1999 and 2008 will continue until 2018. By implementing this input data in the basic model it is possible to estimate the number and age structure of employees leaving Mainfranken (first step in Fig. 3) as well as the spatial patterns of job location mobility for every simulated year (second step in Fig. 3. In

the basic model the age-specific mobility rates of the first step in figure 3 are calculated separately for each year from 1999 to 2008 using SIAB-R 7508 data. As these rates cannot be calculated from 2009 on, the mean values of 1999 to 2008 are employed.

The future development of the different model parameters (number of academics working in the different Mainfranken districts by age group, indicators for regional development of all source and destination areas) is determined by applying average growth factors (w^*), which are calculated separately for each variable and each job location from 1999 on to the last obtainable annual value in secondary statistics (e.g. STELAND 2004, 26):

$$w^* = \sqrt[n]{w_1 \cdot \dots \cdot w_n} \tag{eq. 4}$$

with: w^* : average growth factor for a specific variable; w_i : growth factor of period i ; n : number of periods i .

and:

$$w_i = \frac{B_i}{B_{i-1}} \tag{eq. 5}$$

with: B_i : value of a variable at the end of period i ; B_{i-1} : value of a variable at the end of the previous period of i .

In scenario I, 1,692 academics left Mainfranken’s labour market between 1999 and 2008. Using the described procedure of simulating future job location mobility the number of outflows between 2009 and 2018 is estimated as 2,355. This corresponds to an increase of +39% between the two decades. Looking at the number of mobility cases of each simulated year a similar increase within both periods can be determined starting from 160 in 1999 to 217 cases in 2008 (increase of +36%) and 199 in 2009 to 270 cases in 2018 (again an increase of +36%). When comparing the age structure of both periods (see Fig. 5) the influence of the demographic change in Mainfranken becomes apparent as the percentage of employees leaving Mainfranken between the ages of 40 to under 50 years (16% to 17%) and 50 years and older (8% to 13%) will increase. The simulation runs also show that the share of academics younger than 30 years by the total number of outflows also will tend to increase (from 23% to 30%). This could be interpreted as a result of growing difficulties for young and inexperienced highly qualified persons to find a job in Mainfranken but it could also be an effect of the general up-skilling of the younger population or the shortening of the training time in Germany’s educational system.

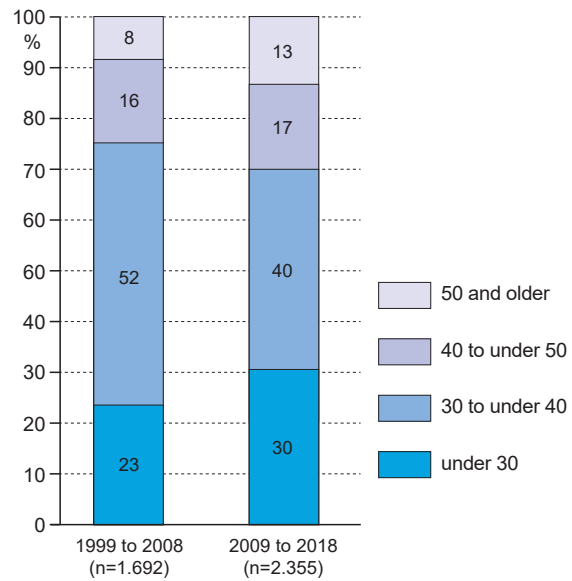


Fig. 5: Age structure of employees leaving Mainfranken job locations between 1999 to 2008 and 2009 to 2018

As a result of the growing outflow numbers one major difference is that the dispersion of spatial allocations between 2009 and 2018 compared to the previous decade can be characterised as generally more wide spread although shorter job locations reach slightly higher shares: while the maximum destination distances (519 km from 1999 to 2008 and 544 km between 2009 and 2018) and the standard deviation (86 km between 1999 and 2008, 89 km from 2009 to 2018) will increase, the mean distance will decline (from 153 km to 148 km). The overall impression is that the spatial patterns of both simulated decades on a small-scale level of consideration are comparable. Destination areas that reach higher percentages of outflows between 1999 and 2008 (see Fig. 4) will retain their importance for the period between 2009 and 2018. Nevertheless, if the results of both simulation runs are aggregated on the level of the German federal states, fewer changes can be detected (Tab. 4): in scenario II, Bayern destination areas will clearly gain importance and attain the greatest increase (4.0%). Higher shares are also reached in Rheinland-Pfalz, Baden-Württemberg (0.8% each) and Hamburg (0.4%). In contrast, especially Nordrhein-Westfalen (-3.9%) and the Eastern German federal states Thüringen (-0.3%), Sachsen-Anhalt (-0.5%) and Sachsen (-1.3%) will lose their importance as job locations for former Mainfranken academics.

Considering the destination areas’ structure according to BBSR’s 2009 district classification changes are barely noticeable: In both decades academics

Tab. 4: Destination areas of academics leaving a Mainfranken job location by German federal states – comparison of the two decades 1999 to 2008 and 2009 to 2018

	I Destination areas 1999 to 2008	II Destination areas 2009 to 2018	Difference between II and I
Bayern	26.6%	30.6%	4.0%
Rheinland-Pfalz	1.3%	2.1%	0.8%
Baden-Württemberg	19.0%	19.8%	0.8%
Hamburg	0.8%	1.2%	0.4%
Schleswig-Holstein	0.1%	0.3%	0.2%
Bremen	0.1%	0.3%	0.2%
Berlin	1.9%	2.1%	0.2%
Brandenburg	0.4%	0.5%	0.1%
Mecklenburg-Vorpommern	0.1%	0.2%	0.1%
Saarland	0.2%	0.1%	-0.1%
Niedersachsen	2.9%	2.7%	-0.2%
Hessen	17.9%	17.7%	-0.2%
Thüringen	9.8%	9.5%	-0.3%
Sachsen-Anhalt	1.6%	1.1%	-0.5%
Sachsen	5.6%	4.3%	-1.3%
Nordrhein-Westfalen	11.6%	7.7%	-3.9%
n	1.692	2.355	663

Source: own simulation results

mainly take up new jobs in core cities (52.0% between 1999 and 2008 and 52.3% from 2009 to 2018) and their densely populated surroundings (29.6% respectively 28.7%). Rural surroundings (4.8% respectively 5.1%) or rural areas (13.6% respectively 13.9%) are chosen far less frequently.

5 Discussion and conclusions

With reference to the first aim mentioned in the introduction the reflection of the analysis' findings allows pointing out three general gains:

1) On an individual level, the concept of job location mobility as described in this paper is able to combine aspects of employment, migration and mobility research, e.g. multilocality, commuting as well as the

increasing necessity to be spatially mobile by omitting place of residence-related approaches. Furthermore, examining job location mobility flows enables municipalities and regions to determine structural deficits in their labour market by comparing them to regions they are competing with. This clearly leads to an advantage in the global war for talents (FÖBKER et al. 2014).

2) The data analysis reveals spatial patterns and frame conditions under which job location mobility is realised by both academics and OHQEs. However, due to restrictions in the dataset, it was only possible to simulate the regional labour market mobility of academics and not that of OHQEs. The future statistics will, due to an extension of survey contents (BA 2012, 4) also include information specific to OHQEs and thus allow simulating their job location mobility as well.

3) Biographical longitudinal data made available through SIAB-R 7508 offers a broad range of socio-demographic and work-related framework conditions as well as spatial relations for both academics and OHQEs. It extends the analysis spectrum of (aggregated) statistics in labour market geography and has proven to be a suitable data source for generating knowledge about job location mobility.

Besides these positive aspects it is important to stress that the data structure limits the analysis' scope. On the one hand aggregating variables in order to prevent identifications of individuals only allows to operationalise intraregional job location mobility between aggregated districts and urban communes of at least 100,000 inhabitants. This leads to a loss of information, as the data only allows to distinguish between six aggregated job locations instead of the official nine districts and urban communes in Mainfranken, especially intraregional job location mobility cannot be operationalised to the full extent. On the other hand information on personal motives, intentions or social networks influencing allocation and matching processes on the labour market (e.g. GRANOVETTER 1995; SOUSA-POZA and HENNEBERGER 2002; GUTH 2007; VERWIEBE et al. 2010) is not contained in the dataset. Consequently, motivation research is still called for in order to be able to complete models of mobility between labour markets.

Based on the empirical findings of this study a modelling approach simulating job location mobility was developed. It allows estimating the future development of labour market segments and the mobility between labour markets. To supplement findings on an analytical basis as described above it also generates knowledge, which can be used by regional players to determine future needs for action. In contrast to other models of labour mobility (e.g. FASSMANN 2002; WINDZIO 2004 and 2007; DAMELANG 2007) it is based on multi-optional decision-making processes on an individual level. This allows implementing different assumptions, like preferred structures of potential new labour markets.

Although the high levels of goodness-of-fit measures attest a rather satisfying quality, it has to be argued, that it oversimplifies the complex job matching process. Even though the spatial allocation of employees is realised individually (for example two persons with the same demographic features can take up a job in different locations), the model still has a deterministic character. Important micro-level elements of the allocation and matching process on the labour market such as losing a job or

starting to search for a new job, the influences of social networks (e.g. by the household, the partner, family or friends; REINDL et al. 2011; HUFFMAN et al. 2013; SHINOZAKI 2014) or the demand for workforce on the firm level (e.g. BOSCHMA et al. 2009) are not taken into account. Also the role of municipal administrations (FÖBKER et al. 2014) or institutions in a national respectively transnational context (RHEIN 2010, 4; HEDBERG et al. 2014; SCHNEIDER 2011, 66; LEUNG 2014) as well as the complex influence of the choice of residence (SEYNSTAHL 2015a, 302; 2015b, 54ff.) is not implemented. To employ the concept of a complex spatial micro-simulation model it is necessary to use micro-data both for the supply and the demand side of the labour market. Until now it is only possible to access depicted to the day individual data for the supply side of the labour market like SIAB-R 7508. But even this data does not provide the information needed to model cognitive operations that influence individual employees' job location mobility. To actually simulate the matching process on a micro-level, information on the demand of workforce for each and every German firm, such as quantity, qualification requirements or temporal limitations of vacant positions, long-term expansion strategies or plans to reduce the size of the permanent workforce etc., is relevant. In 2012 the German business register listed 3.9 million firms (STATISTIKPORTAL 2014). Of course not every company employs highly qualified workers – nevertheless this number offers a rough impression of how extensive the required information to create a more “realistic” and sufficiently complex micro-simulation model is.

Next to this more critical point of view there are also some arguments that clearly show the advantages of the model. First of all the procedure can be used to simulate job location mobility of different labour market segments, e.g. for those of the vocational workers. Furthermore, it is possible to simulate the spatial mobility of all German labour markets. This offers the opportunity to also model intraregional job location mobility or inflows to the Mainfranken labour market. Another advantage is that the complete simulation can be created relatively quickly with one simulation run taking a fraction of a second – and not as in the case of complex micro-simulations (e.g. using multi-agent systems; see HARDER 2011, 179) several days. Moreover, as a typical characteristic of all micro-simulations (HESSE and RAUH 2003, 71f.) it is possible to add further variables to the model or simulate inhomogeneous populations.

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