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* This paper reflects the authors’ personal opinion and does not necessarily reflect the views of the Federal Ministry of Economic Affairs and Energy or its staff.

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Abstract

Job mobility equilibrates disparities on local labor markets and influences the efficiency of the job matching process. In this paper, we describe a job matching model that allows for simultaneous regional and occupational mobility, predicting corresponding spillover effects on the number of matches. We estimate these spillover effects based on novel administrative German data on the number of matches, unemployed, and vacancies of local labor markets, which we define as distinct occupations in distinct regions. We specify a matching function for these local labor markets with regional spillovers, occupational spillovers, as well as combined regional and occupational spillovers of unemployed and vacancies. To construct these spillover terms, we use information on the proximity between regions and on similarities between occupations in terms of qualification requirements and tasks. We find that regional spillover effects for both vacancies and the unemployed are positive, occupational spillover effects for vacancies are positive and occupational spillover effects for the unemployed are negative. The combined regional and occupational spillover effects for both vacancies and the unemployed are positive. We conclude that neglecting regional, occupational, and combined spillovers leads to biased estimates of job matching efficiency in local labor markets.

Zusammenfassung

Die Mobilität von Arbeitnehmern kann Ungleichheiten in lokalen Arbeitsmärkten ausgleichen und beeinflusst die Effizienz des Matching-Prozesses. Dabei verstehen wir unter lokalen Arbeitsmärkten das Arbeitsangebot und die Arbeitsnachfrage in einer Region in den verschiedenen Berufen. Wir konstruieren ein Suchmodell, das sowohl regionale als auch berufliche Mobilität berücksichtigt. Mit diesem Modell beschreiben wir, wie die Jobsuche von Arbeitnehmern im eigenen und in anderen Berufen sowie im heimischen und in anderen Regionen die Anzahl der daraus resultierenden Neueinstellungen in Form von Spillovereffekten beeinflusst. Wir schätzen diese Spillover-Effekte auf der Basis detaillierter administrativer Daten aus Deutschland. Hierfür spezifizieren wir eine Matching-Funktion für lokale Arbeitsmärkte mit regionalen, beruflichen sowie kombinierten regionalen und beruflichen Spillover-Effekten für Arbeitslose und Vakanzen. Dabei treffen wir Annahmen zur Abhängigkeitsstruktur der lokalen Arbeitsmärkte, die auf regionalen Distanzen und Informationen zu Ähnlichkeiten von Berufen hinsichtlich der Qualifikations-Anforderungen und Tätigkeiten beruhen. Die Ergebnisse zeigen positive regionalen Spillover-Effekte der Vakanzen und der Arbeitslosen sowie positive berufliche Spillover-Effekte der Vakanzen, wohingegen die beruflichen Spillovereffekte der Arbeitslosen negativ sind. Die kombinierten regionalen und beruflichen Spillover-Effekte sind sowohl für die Vakanzen als auch für die Arbeitslosen positiv. Wir schlussfolgern auf der Basis eines Vergleichs mit einer herkömmlichen Matchingfunktion, dass die Vernachlässigung von Spillover-Effekten zu verzerrten Schätzungen der Job-Matching-Effizienz in lokalen Arbeitsmärkten führt.

JEL classification: C21, C23, J44, J64

Keywords: Matching function, Job mobility, Local labor markets

1 Introduction

Job mobility, i.e., workers changing jobs across regions and occupational titles,[1] is a crucial mechanism to equilibrate disparities in local labor markets and, therefore, influence the job matching process and its efficiency (e.g. see Boschma/Eriksson/Lindgren, 2014).

The literature on job matching efficiency typically relies on the estimation of job matching functions that relate the number of flows into employment to the number of vacancies and job searchers; compare with Pissarides (1979, 1985); Diamond (1982a,b); Mortensen, Dale T. (1982) and the surveys by Rogerson/Shimer/Wright (2005); Yashiv (2007). Petrongolo/Pissarides (2001) refer to the matching function as a black box because the multiple factors that can affect the hiring process are not observable at the aggregate level. Coles/Smith (1996) state that the estimation of matching efficiency at an aggregated level is substantially biased because the matching process takes place in local labor markets (Dauth/Hujer/Wolf, 2016).

There are studies complementing the explaining part of both theoretic and empirical matching functions for local labor markets with spillover terms, particularly vacancies and unemployed from related local labor markets like nearby regions or similar occupations, therefore, showing the relevance of job mobility on job matching (Burda/Profit, 1996; Fahr/Sunde, 2006; Hensen/de Vries/Cörvers, 2009; Lottmann, 2012; Stops, 2014a; Haller/Heuermann, 2016). These studies conclude that spillovers are important for estimating the direct effect of the unemployed and vacancies on the number of matches within a local labor market and should not be neglected.

Up to now, empirical studies fail to simultaneously analyze both regional and occupational job mobility, although job changes can be associated with a change of both the region and the occupation. In this paper, we incorporate regional spillovers, occupational spillovers, as well as combined regional and occupational spillovers in the matching function to study, to the best of our knowledge for the first time, how these spillovers simultaneously influence the estimates of the matching efficiency.

The notion of local labor markets in the literature is mainly related to regional labor markets. For instance, the studies of Burda/Profit (1996); Fahr/Sunde (2006); Lottmann (2012); Haller/Heuermann (2016) document the sizeable influence of the unemployed and vacancies in close local areas on matching. Nevertheless, the dependence structure of local labor markets goes beyond geography. For instance, Machin/Pelkonen/Salvanes (2008) and Hensen/de Vries/Cörvers (2009) report that educational levels significantly affect patterns of regional mobility, while Broersma/van Ours (1999) report different matching efficiencies in different sectors. Fahr/Sunde (2004) as well as Stops/Mazzoni (2010) document that matching efficiency is heterogeneous across different occupational labor markets. The

[1] A part of the literature uses the term “job title” instead of “occupational title.” This literature often refers to analyses where the assignment of employment across firms is important. In this paper we use the term “occupational title” because we abstract from firms and focus instead on the assignment of employment across regions and occupations. We define occupations as groups of jobs that share extensive commonalities in terms of skill requirements and tasks.

main caveat of their notion of occupational labor markets is that they disregard possible mobility across occupational labor markets, thus potentially biasing their results.

Stops (2014a) documents the importance of spillovers between occupational labor markets. Analogously to the spatial order of regional labor markets, Stops (2014a) proposes and tests an "occupational topology" that describes groups of occupational labor markets that are assumed to be substitutes, whereas occupational labor markets in different groups cannot substitute for each other. The "borders" between these groups are defined by dissimilarities in job contents, formal requirements, and qualifications. This definition follows Matthes/Burkert/Biersack (2008) and is in line with Gathmann/Schoenberg (2010), who state that workers can transfer their human capital across occupational labor markets, particularly between occupations with similar content.

The present paper combines the theoretical models utilized by Burda/Profit (1996) for regional spillovers and Stops (2014a) for occupational spillovers. Thus, our model considers regional, occupational, as well as combined occupational and regional spillovers in the job matching process. To estimate the spillover effects, we use novel administrative data for Germany that define local labor markets as a combination of the regional and the occupational dimension. Thus, the data contain information on the number of new hires, unemployed, and vacancies for each of 131,454 local labor markets that we define as intersections of 327 occupational orders[2] and 402 NUTS-3 local areas. These data cover the 2000 to 2011 on a monthly basis.

Then, we construct regional spillover terms based on measures of geographical proximity between local areas. Next, we construct occupational spillover terms by using the assignment of occupations with similar task contents and job requirements to occupational segments based on previous work by Matthes/Burkert/Biersack (2008). Finally, we compute a combined spillover term by using the information of both the regional and the occupational spillover terms.

The estimation of an empirical matching function with fixed effects and spillover terms reveals that the spillovers significantly affect the matching efficiencies. Firstly, we find positive regional spillover effects of both unemployed and vacancies in nearby regions and a positive spillover effect of vacancies in similar occupations. This finding corresponds to the direct effect of additional unemployed and additional vacancies on the match probability. In contrast, we, secondly, find a negative occupational spillover effect of unemployed in similar occupations. This can be explained by a negative indirect competition effect on the matching efficiency. Both findings can be also described by our theoretical model. Lastly, we find relatively small but positive combined regional and occupational spillover effects. We conclude that neglecting one or more of the regional, occupational, and combined occupational and regional spillovers leads to biased estimates of the direct effect of the unemployed and vacancies on the number of matches within a local labor market.

The remainder of the paper proceeds as follows. Section 2 discusses the motivation for disaggregated matching functions and the existence of spillovers between local areas and

[2] Occupational orders are defined according to the 3-digit code of the German occupational classifications scheme 1988 ("Klassifizierung der Berufe 1988", KldB 1988).

occupations. Section 3 presents the data, while section 4 contains our empirical strategy and the results. Section 5 presents a robustness check for the specification of occupational segments. Finally, section 6 concludes.

2 Empirical Matching Function with Regional and Occupational Spillover Terms

In the following, we discuss theoretical motivation for regional and occupational spillovers, incorporate them in the empirical matching function, and present our operationalization of regional proximity and occupational similarity.

2.1 Theoretical Considerations on Spillovers

Existence of spillovers over local labor markets can be explained in the theoretical framework of the bulletin board model (Hall, 1979; Pissarides, 1979). Burda/Profit (1996) provide a version of this model for regional labor markets, whereas Stops (2014a) provides its version for occupational labor markets. Appendix A contains the version that differentiates between regional and occupational local labor markets. In all versions, workers send multiple job applications to the vacancies both in their own and the neighboring local labor markets.

The optimal number of applications sent to different labor markets is an outcome of maximization of expected benefits from a new job given the costs. The benefits from an application to another local labor market can be higher, but they come with an additional cost that is proportionate to the distance from the worker's current location to the local labor market she applies to.

Aggregating the individual search behavior over all local labor markets, the model reveals that the job finding probability can be both positively and negatively related to the number of applications. The positive correlation stems from the scope effect of having more applications in the labor market, whereas the negative effect stems from competition of applicants for vacancies. Therefore, allowing workers to search for jobs both in their own and in neighboring labor markets can be either positive or negative, based on the interplay of the scope and competition effects. Similarly, Albrecht/Gautier/Vroman (2003), in an alternative model setting, conclude that multiple applications in a non-sequential search leads to a coordination problem, which results in additional search costs.

2.2 Spillovers in the Empirical Matching Function

In a homogeneous labor market, the matching technology between the pool of unemployed workers and existing vacancies can be described by a matching function. Without an explicit definition of the matching process, the aggregated matching function captures the technology that brings the unemployed (denoted by U) and the vacancies (denoted by V) together, resulting in a job match (denoted by M):

$$M = M(U, V) = A\, U^{\beta_U} V^{\beta_V}, \tag{1}$$

where A describes the factor-unrelated matching productivity or the technology parameter, respectively. The parameters β_U and β_V represent the matching elasticities of unemployed and vacancies, respectively.

Labor mobility between local areas in order to overcome discrepancies in regional supply and demand is well documented in empirical studies (Burda/Profit, 1996; Fahr/Sunde, 2006; Hensen/de Vries/Cörvers, 2009; Lottmann, 2012; Haller/Heuermann, 2016). Regional mobility varies substantially, even between European countries (van Ours, 1990). Although the overall mobility rates in Germany are moderate in international comparison, the yearly mobility rate between German districts (Kreise) rose from about five percent of all employees in the 1980s to about eight percent in mid-1990s (Haas, 2000). Arntz (2005) documents substantial mobility of the unemployed across labor market regions.

Therefore, we assume that within a regional local labor market $l = 1, \ldots, L$, the matching process involves both the unemployed and the vacancies from local area l, as well as the unemployed and the vacancies from other local areas $m = 1, \ldots, M$, $m \neq l$. We assume that less distant local areas are more related to each other in terms of job search and worker recruiting than more distant local areas. Formally, this assumption results in an extension of the matching function by the stock of the unemployed U_m with its elasticity γ_{U_r} and the number of vacancies V_m with its elasticity γ_{V_r} in closer local areas m (this approach is similar to Burda/Profit, 1996):

$$M_l = M(U_l, V_l, U_m, V_m) = A\, U_l^{\beta_U} V_l^{\beta_V} U_m^{\gamma_{U_r}} V_m^{\gamma_{V_r}}. \tag{2}$$

The connectedness of regional labor markets is highly non-random (Fahr/Sunde, 2006). Lottmann (2012) provides empirical tests for spatial dependency in the German labor market, also showing that spatial dependency has grown since 2000. Most studies of regional spillovers in the matching function employ a geographic spatial structure given by geographic proximity between local areas (Lottmann, 2012; Haller/Heuermann, 2016); this approach is also often used for other applications in the spatial literature (e.g., Hautsch/Klotz, 2003).[3]

Apart from the geographical connectedness between local areas, several other definitions of local labor markets can be applied. For instance, Broersma/van Ours (1999) document the heterogeneities in the matching technology in different industries. However, Fahr/Sunde (2004), Kambourov/Manovskii (2008) and Stops/Mazzoni (2010) observe the strongest influence on the patterns of the matching efficiency on occupational labor markets.

[3] Possible alternatives would be to employ the measures of average time needed to cover the distance between local areas or other types of transport connectedness between local areas. However, these alternatives might not fulfill the condition of the spatial structure being exogenous to the matching technology. Furthermore, Haller/Heuermann (2016) empirically show that, compared to the mentioned alternatives and based on a similar German data set, regional distances turned out to be the best approximation for regional spillovers.

The connectedness of occupational labor markets is observed based on the frequency of occupational switches (see Fitzenberger/Spitz, 2004). E.g., for the German labor market, Stops (2014a) reports shares of flows in employment that involve occupational changes of 16 to 75 percent. Analogously to the spatial dependence between local areas, Gathmann/Schoenberg (2010) show that occupational mobility also follows a particular pattern that is related to content similarity between occupations.

Thus, we assume that, regarding matches in occupation $i = 1, \ldots, I$, the matching process can involve unemployed and vacancies from similar occupations $j = 1, \ldots, J$, $j \neq i$. Consequently, we extend the occupation-specific matching function with U_j with elasticity γ_{U_o} and V_j with elasticity γ_{V_o} (compare also with Stops, 2014a):

$$M_i = M(U_i, V_i, U_j, V_j) = A\, U_i^{\beta_U} V_i^{\beta_V} U_j^{\gamma_{U_o}} V_j^{\gamma_{V_o}}. \tag{3}$$

Job search evolves simultaneously along regional and occupational dimensions, which should be reflected in the patterns of job mobility. We conclude that the matching technology for occupation i in local area l can be further adjusted by allowing spillovers from both occupations with similar contents j and other local areas m:

$$\begin{aligned} M_{il} &= M(U_{il}, V_{il}, U_{im}, V_{im}, U_{jl}, V_{jl}, U_{jm}, V_{jm}) \\ &= A\, \underbrace{U_{il}^{\beta_U} V_{il}^{\beta_V}}_{\substack{\text{direct} \\ \text{effect}}} \underbrace{U_{im}^{\gamma_{U_r}} V_{im}^{\gamma_{V_r}}}_{\substack{\text{regional} \\ \text{spillover}}} \underbrace{U_{jl}^{\gamma_{U_o}} V_{jl}^{\gamma_{V_o}}}_{\substack{\text{occupational} \\ \text{spillover}}} \underbrace{U_{jm}^{\gamma_{U_{ro}}} V_{jm}^{\gamma_{V_{ro}}}}_{\substack{\text{combined} \\ \text{regional and} \\ \text{occupational} \\ \text{spillover}}} \end{aligned} \tag{4}$$

The latter equation is an approximation of what we understand as connected regional and occupational labor markets.

3 Data

We use data on outflows from unemployment into employment and stocks of unemployed and registered vacancies. These data stem from a unique administrative panel data set for 327 occupational orders in 402 NUTS-3 local areas with 138 observation periods from January 2000 to June 2011. The occupational orders are coded according to the German occupational classification scheme (3 digits, KldB88). All the data stem from the Federal Employment Agency.

We separately compute regional and occupational lags of unemployment and vacancy stocks. For the regional lags, we define the proximity of two local areas to be represented by the distance between geographic centers measured in kilometers. Based on this information, a 402×402 weights matrix is constructed. This matrix is row-normalized and

the diagonal elements are set to 0, which corresponds to the fact that a local area cannot neighbor itself. The resulting weights matrix $\mathbf{W^R}$ is used to compute proximity-weighted averages of the stocks of unemployed and vacancies for each region in each single occupation:

$$\bar{\mathbf{U}}^{\mathbf{R}} \equiv (\mathbf{I}_{327} \otimes \mathbf{W}^{\mathbf{R}})\mathbf{U} \quad \text{and} \quad \bar{\mathbf{V}}^{\mathbf{R}} \equiv (\mathbf{I}_{327} \otimes \mathbf{W}^{\mathbf{R}})\mathbf{V}, \tag{5}$$

The vectors $\bar{\mathbf{U}}^{\mathbf{R}}$ and $\bar{\mathbf{V}}^{\mathbf{R}}$ of dimension 131,454 contain the (contiguity) weighted sums of unemployment stocks, U_{im}, and registered vacancies, V_{im}, in other regions; the single elements of these vectors are denoted as U_{im} and V_{im} in equation (4). $\mathbf{I}_{327}$ is an identity matrix of dimension 327 that corresponds to the number of occupational orders. $\mathbf{U}$ and $\mathbf{V}$ denote the vectors of dimension 131,454 containing all observations on unemployment stocks and registered vacancies, respectively.

Analogous to the regional proximity, we use an occupational "topology," which classifies occupations into groups that are similar based on their content and qualification requirements. More specifically, we use the work by Matthes/Burkert/Biersack (2008) that assigns 327 occupational orders into 21 segments with similar job requirements (see table 3 in the Appendix). The approach is similar to the study by Gathmann/Schoenberg (2010), who define content proximity between occupations based on detailed survey information on tasks performed in the jobs. The methodology of Matthes/Burkert/Biersack (2008) relies on information from the Federal Employment Agency and its Central Occupational File, which contains groups of occupations that can be regarded as close alternatives and that are actually used in recruitment decisions by firms and job searchers. The identified similarities between occupations are derived from similarities between the specific skills, licenses, certificates, knowledge requirements, as well as tasks and techniques that are typical for each occupation. Stops (2014a) already applies an occupational topology a in spatial analysis to investigate spillovers between occupations (for more details including methodological aspects of the work by Matthes/Burkert/Biersack (2008) see Stops, 2014b). His topology is constructed for two-digit occupational groups, whereas this study relies on an occupational topology that is based on detailed three-digit occupational orders.

With information on occupational proximity at hand, we construct a 327×327 first-order contiguity weights matrix, in which an entry of 1 denotes two occupational orders belonging to the same occupational segment. We row-normalize it and replace the diagonal elements with zeros. Hence, the resulting matrix $\mathbf{W^O}$ contains information on similarities between the occupational orders and it is used to compute occupational similarity-weighted averages of the stocks of unemployed and vacancies in each occupational order in each single region:

$$\bar{\mathbf{U}}^{\mathbf{O}} \equiv (\mathbf{W}^{\mathbf{O}} \otimes \mathbf{I}_{402})\mathbf{U} \quad \text{and} \quad \bar{\mathbf{V}}^{\mathbf{O}} \equiv (\mathbf{W}^{\mathbf{O}} \otimes \mathbf{I}_{402})\mathbf{V} \tag{6}$$

The vectors $\bar{\mathbf{U}}^{\mathbf{O}}$ and $\bar{\mathbf{V}}^{\mathbf{O}}$ of dimension 131,454 denote the occupational similarity-weighted sums of unemployment stocks and registered vacancies in other occupations; the single elements of these vectors are denoted as U_{jl} and V_{jl} in equation (4). $\mathbf{I}_{402}$ is an identity matrix of dimension 402 that corresponds to the number of regions.

In the next step, we combine regional proximity and occupational similarity by augmenting the occupational weights matrix $\mathbf{W^O}$ with regional information. Technically, we compute the Kronecker product of $\mathbf{W^O}$ and $\mathbf{W^R}$, thus

$$\mathbf{W^{OR}} = \mathbf{W^O} \otimes \mathbf{W^R}. \tag{7}$$

After row-normalizing and replacing the diagonal elements with zeros, we obtain a $131,454 \times 131,454$ weights matrix $\mathbf{W^{OR}}$ that is now used to weight the stock of unemployed $\mathbf{U}$ and vacancies $\mathbf{V}$ for all occupational orders and all local areas depending on occupational similarity and regional proximity to all other observations:

$$\bar{\mathbf{U}}^{\mathbf{OR}} \equiv \mathbf{W^{OR}U} \quad \text{and} \quad \bar{\mathbf{V}}^{\mathbf{OR}} \equiv \mathbf{W^{OR}V} \tag{8}$$

Here, $\bar{\mathbf{U}}^{\mathbf{OR}}$ and $\bar{\mathbf{V}}^{\mathbf{OR}}$ contain the sums of unemployment stocks and registered vacancies from all local labor markets weighted by regional proximity and occupational similarity; these sums are denoted as U_{jm} and V_{jm} in equation (4).

Finally, to obtain unbiased matching parameter estimates, we adjust the data set with observations for occupations and NUTS-3 regions, respectively, where vacancies, unemployed or flows into employment are zero. This leads to an unbalanced panel data structure with 2,394,250 observations. Table 1 shows some descriptive statistics for all measures.

Table 1: Descriptive statistics

Monthly averages 2000-2011 (per local area and occupational order)		Mean	St. dev.
Exits into employment	M_{il}	11.2	(22.8)
Unemployment stock	U_{il}	156.0	(410.8)
Regional lags of unemployment stocks	U_{im}	125.7	(165.9)
Occupational lags of unemployment stocks	U_{jl}	54.6	(126.6)
Regional lags of unemployed stocks, adjusted by occupational proximity	U_{jm}	36.5	(23.2)
Registered vacancies stock	V_{il}	14.8	(34.5)
Regional lags of registered vacancies stocks	V_{im}	10.5	(10.7)
Occupational lags of registered vacancies stocks	V_{jl}	5.1	(11.2)
Regional lags of vacancies stocks, adjusted by occupational proximity	V_{jm}	3.4	(2.1)

Source: Administrative data of the Federal Employment Agency 2000-2011. Own computations.

4 Estimation of Spillovers

Taking logarithms of the model described by equation (4) and adding a time index t for the month of observation yields the following specification:

$$\begin{aligned} \log M_{il,t} = &\log A + \beta_U \log U_{il,t} + \beta_V \log V_{il,t} + \gamma_{U_r} \log U_{im,t} + \gamma_{V_r} \log V_{im,t} \\ &+ \gamma_{U_o} \log U_{jl,t} + \gamma_{V_o} \log V_{jl,t} + \gamma_{U_{ro}} \log U_{jm,t} + \gamma_{V_{ro}} \log V_{jm,t} + \epsilon_{il,t}, \end{aligned} \tag{9}$$

The error term, $\epsilon_{il,t}$, consists of regional, occupations, and time fixed effects as well as a random error term, i.e., $\epsilon_{il,t} = \epsilon_l + \epsilon_i + \epsilon_t + e_{il,t}$.

Table 2 presents the results of the estimation of equation (9) using OLS and fixed effects estimators.[4] The results of the specifications (OLS), (FE1), and (FE2) are based on a basis specification of the matching function without spillover effects. The OLS specification does not contain any of the fixed effects. The specification for the results in column (FE1) is complemented with regional and occupational fixed effects and the specification in column (FE2) additionally contains time fixed effects. Specifications (FE3)–(FE5) are stepwise complemented with only regional spillovers, whereas specifications (FE6)–(FE8) are stepwise complemented with only occupational spillovers. Specifications (FE9)–(FE11) include only the combined regional and occupational spillovers. Finally, specification (FE12) contains the full set of regional spillovers, occupational spillovers, plus the combined regional and occupational spillovers. We calculate the standard errors using White's heteroskedasticity-consistent estimator.

The matching elasticities of the unemployed and vacancies are significantly positive throughout all specifications. The estimated elasticity of matches with respect to the unemployed is higher than the matching elasticity with respect to vacancies, which is in line with the existing estimates for Germany (Burda/Wyplosz, 1994; Fahr/Sunde, 2004; Stops/Mazzoni, 2010; Stops, 2014a, 2016). These matching elasticities remain qualitatively unchanged when introducing regional, occupational, and time fixed effects (specifications FE1 and FE2).

Specifications (FE3)–(FE5) include regional spillover terms of the unemployed and vacancies in nearby regions. The coefficient of the regional spillover term of the unemployed is significantly positive and smaller than the corresponding direct effect ($|\beta_U| >> |\gamma_{U_r}|$), whereas the coefficient of the regional spillover term of the vacancies is also significantly positive but larger than the corresponding direct effect ($|\beta_V| << |\gamma_{V_r}|$). Introduction of both regional spillover terms of the unemployed and vacancies in the nearby local areas to specification (FE5) does not change the magnitude of the corresponding coefficients in the specifications that includes only one of these both spillover terms (FE3) and (FE4).

Specifications (FE6)–(FE8) include spillover terms of the unemployed and vacancies from similar occupations. The coefficients of both occupational spillover terms are substantially lower than the corresponding direct effects ($|\beta_U| >> |\gamma_{U_o}|$ and $|\beta_V| >> |\gamma_{V_o}|$). The spillover effect of the unemployed in similar occupations is significantly negative, whereas

[4] Some of the related studies consider empirical specifications involving spatial lags of the dependent variable or the error term to empirically exploit matching efficiency on local labor markets, compare, e.g., with Lottmann (2012); Haller/Heuermann (2016). We abstain from using such specification due to their sensitivity to the real data generating process (DGP), which makes identification of the "true" model impossible (Gibbons/Overman, 2012). This implies that the real DGP should be reflected and assumptions on the real DGP should be well founded by theory (see Elhorst/Vega, 2015). In our paper, we propose such a suitable theoretical model that allows for directly deriving and estimating a matching function with spillover effects using the explaining variables. The model does not describe a matching process that involves new hires on a local labor market that (at least partly) depends on (simultaneously generated) hires in other local labor markets. Our model also does not deliver reasons for the assumption that our estimation results suffer from an omitted variable bias of spatially dependent unobservables that potentially could, beside others, result in spatially dependent error terms.

Table 2: OLS and FE estimation of a matching function across occupational and regional labor markets

Model	(OLS)	(FE 1)	(FE 2)	(FE 3)	(FE 4)	(FE 5)	(FE 6)	(FE 7)	(FE 8)	(FE 9)	(FE 10)	(FE 11)	(FE 12)
β_U	0.573***	0.514***	0.623***	0.564***	0.623***	0.566***	0.639***	0.626***	0.641***	0.624***	0.623***	0.620***	0.581***
	(0.000)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
β_V	0.115***	0.060***	0.040***	0.040***	0.028***	0.028***	0.038***	0.036***	0.034***	0.040***	0.036***	0.037***	0.025***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
γ_{U_r}				0.128***		0.125***							0.112***
				(0.004)		(0.004)							(0.004)
γ_{V_r}					0.073***	0.071***							0.053***
					(0.002)	(0.002)							(0.002)
γ_{U_o}							-0.058***		-0.056***				-0.040***
							(0.003)		(0.003)				(0.003)
γ_{V_o}								0.024***	0.022***				0.017***
								(0.001)	(0.001)				(0.001)
$\gamma_{U_{ro}}$										-0.009**		0.036***	0.049***
										(0.004)		(0.004)	(0.005)
$\gamma_{V_{ro}}$											0.095***	0.101***	0.077***
											(0.003)	(0.003)	(0.003)
Constant	-0.784***	-0.428***	-0.970***	-1.261***	-1.086***	-1.367***	-0.843***	-0.996***	-0.872***	-0.941***	-1.060***	-1.179***	-1.466***
	(0.001)	(0.013)	(0.014)	(0.017)	(0.015)	(0.018)	(0.014)	(0.014)	(0.014)	(0.016)	(0.014)	(0.017)	(0.019)
Regional and occupational fixed effects:		x	x	x	x	x	x	x	x	x	x	x	x
Time fixed effects			x	x	x	x	x	x	x	x	x	x	x
Observations	2,394,250	2,394,250	2,394,250	2,394,250	2,394,250	2,394,250	2,394,250	2,394,250	2,394,250	2,394,250	2,394,250	2,394,250	2,394,250
R-squared	0.657	0.206	0.304	0.307	0.306	0.308	0.305	0.304	0.305	0.304	0.306	0.307	0.311
Number of id		55,422	55,422	55,422	55,422	55,422	55,422	55,422	55,422	55,422	55,422	55,422	55,422

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Administrative data of the Federal Employment Agency 2000-2011. Own computations.

the spillover effect of vacancies in similar occupations is significantly positive. Considering the results of our theoretical model in appendix A, the unemployed affect the number of matches negatively because the negative indirect competition effect on the matching efficiency due to a lower individual job finding probability is stronger than the positive direct effect on the matching efficiency. The magnitudes of spillover coefficients in specification (FE6) with both occupational spillover terms of vacancies and unemployed remain virtually unchanged compared with the specifications (FE7) and (FE8) that include either the occupational spillover term of unemployed or the occupational spillover term of vacancies.

Specifications (FE9)–(FE11) include the combined regional and occupational spillover terms of the unemployed and vacancies in similar occupations in nearby regions. The combined regional and occupational spillover effect of the unemployed in similar occupations from nearby local areas is relatively small and significantly negative when it is separately included (specification FE9). The combined regional and occupational spillover effect of the vacancies in similar occupations from nearby local areas is significantly positive. In specification (FE11), with both effects, the sign of the spillover effect of the unemployed significantly changes and its magnitude is four times larger than in specification (FE9). Similar to specifications (FE3)–(FE5), the indirect effect of the unemployed in similar occupations from nearby local areas on matching elasticity is substantially smaller than the direct effect ($|\beta_U| >> |\gamma_{U_{ro}}|$), while the indirect effect of the vacancies is notably higher than the direct effect ($|\beta_V| << |\gamma_{V_{ro}}|$).

In specification (FE12) we include regional spillovers, occupational spillovers plus the combined regional and occupational spillover terms. The relative size of the direct effect of the unemployed and vacancies as well as the different spillover effects is robust compared with the previous specifications. However, the size of the direct effect of the unemployed and vacancies (β_U and β_V) is affected by the introduction of the spillover terms.

Comparing β_U and β_V in (FE2) and (FE12) shows that neglecting spillover effects leads to an overestimation of the direct effects of the matching elasticity with respect to unemployed and vacancies. More specifically, comparison of (FE2) and (FE5) shows that negligence of regional spillovers results in overestimation of the matching elasticities, both with respect to unemployed and vacancies. Comparison of (FE2) and (FE8) reveals that negligence of occupational spillovers underestimates the matching elasticity with respect to the unemployed and slightly overestimates the matching elasticity with respect to vacancies.

We also conclude from specifications (FE6), (FE8), and (FE12) that the stock of unemployed from similar occupations intensifies competition among job seekers, leading to a lower efficiency of the matching technology. This corresponds to the indirect effect of the stock of unemployed on the job finding probability through the job search intensity, described by our theoretical framework in appendix A. All other spillover effects are significantly positive.[5]

Finally, the estimates of specification (FE12) reveal that the coefficients for regional spillovers

[5] This includes the effects of the unemployed and vacancies in nearby local areas in specifications (FE3)–(FE5) and (FE12), of vacancies in similar occupations in specifications (FE7) and (FE8), and the unemployed and vacancies in similar occupations of nearby local areas in specification (FE9)–(FE12).

sizably exceed the coefficients for occupational spillovers. The results suggest that positive regional spillovers alleviate the negative effect of the unemployed in similar occupations on the matching elasticity. This result corresponds also with the estimates of the combined regional and occupational spillover effects.

5 Robustness of the Occupational Spillover Estimates

As shown above, the usage of the (contiguity) occupational weights matrix adopted from Matthes/Burkert/Biersack (2008) delivers robust and significant estimates for occupational spillovers. Nevertheless, we provide robustness checks for the occupational weights matrix because this matrix is not derived from a "topology" that is naturally given, as is the case for local areas. Analogous to the methodology in Stops (2014a), we conduct an additional indirect validity test for our occupational weights matrix to verify that our estimated effects of occupational spillovers are non-random. In doing so, we construct 500 random matrices of "occupational topologies" that fulfill the following conditions:

- contain the same amount of occupational segments (implying same size of segments as in the empirical "topology");
- are symmetric;
- contain zeros at their main diagonal; and
- prevent occupations from the same empirical occupational segment to be in one random occupational segment.

Next, we re-estimate the fixed effects model of the occupational spillover effects in the matching function using our (contiguity) occupational weights matrix and the constructed random matrices. The regression equation is specified like equation (9) but with one addendum: in order to overcome the potential influence of global economic shocks, we additionally control (in addition to the time fixed effects) for the yearly federal state specific cyclical component of the Gross Domestic Product. The results of the estimation are displayed in figure 1. The horizontal green lines in both charts of the figure correspond to the estimation result based on the empirical "occupational topology" based on the classification of occupations into segments by Matthes/Burkert/Biersack (2008). The solid line corresponds to the point estimates, whereas the dashed lines correspond to the 95 percent confidence intervals.

The point estimates and confidence intervals for the random matrices are substantially and significantly different from the estimates based on (contiguity) occupational weights matrix. Although the size of the coefficients differs substantially, the coefficients from the estimations with random and empirical weight matrices exhibit same direction of influence on the matching technology. In particular, the sign of the coefficient of the randomly weighted unemployed is negative, whereas the sign of the coefficient of the randomly weighted vacancies is positive. Thus, we conclude that the estimation of occupational spillovers described in section 4 captures relationships due to tasks similarities within occupational segments that result in non-random occupational mobility.

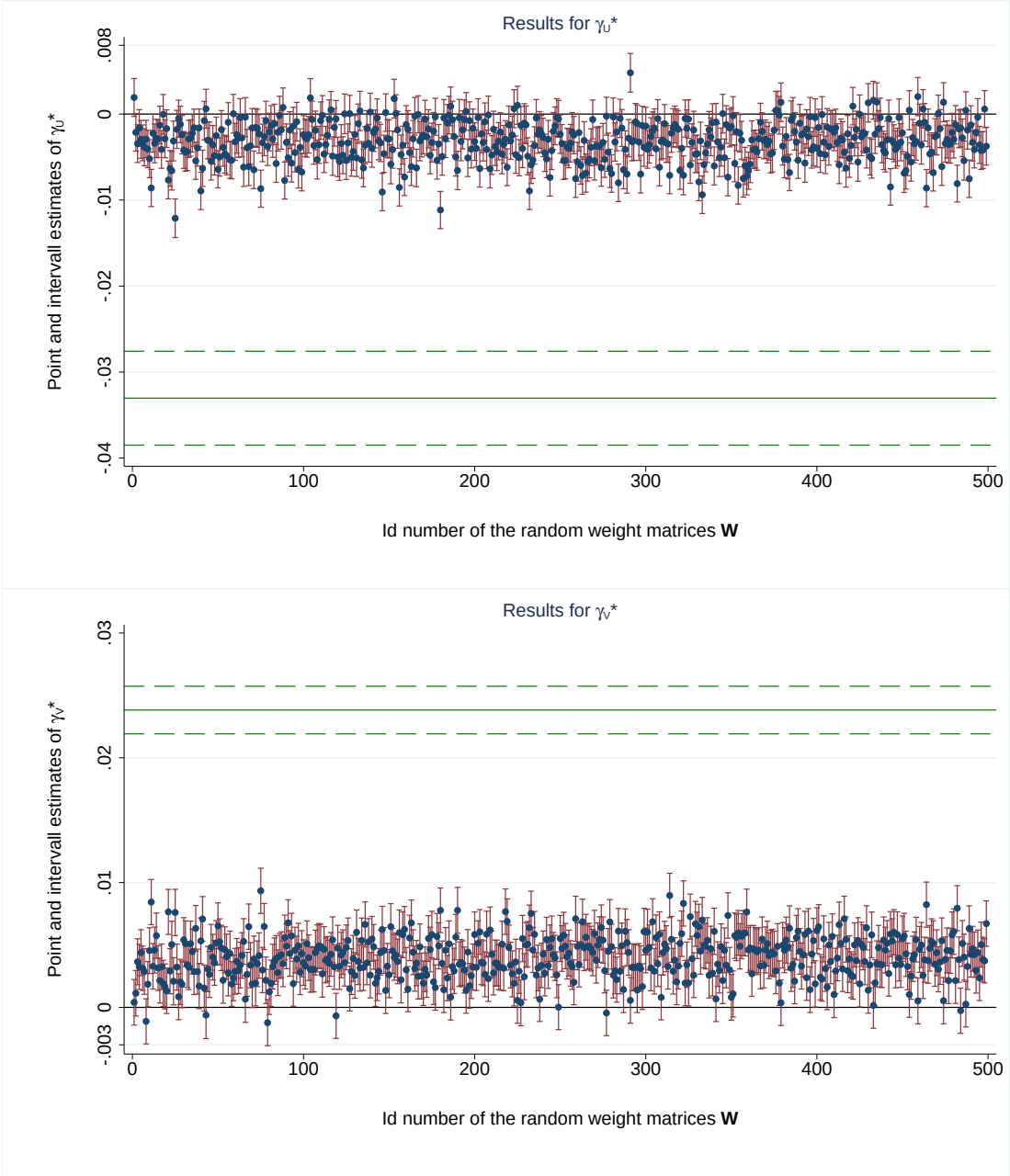

Figure 1: Test of 500 random "occupational topology" matrices in the estimation of the effect of occupational spillovers on matching efficiency.

Notes: Estimates are based on the empirical weight matrix and 500 randomly selected weight matrices. The solid horizontal green lines mark the point estimates and the dotted lines indicate the 95%-confidence interval estimates of the occupational correlations based on the empirically based weight matrix. The blue dots and the vertical red lines mark the point and 95%-interval estimates of the occupational correlations based on randomly selected weight matrices of non-similar occupational groups.
Source: Administrative data of the Federal Employment Agency 2000-2011. Own computations.

6 Conclusion

In this paper, we estimate an empirical matching function with regional spillovers, occupational spillovers, as well as combined regional and occupational spillovers. Our analyses rely on a highly disaggregated data set that contains information on new matches, unemployed and vacancies in local labor markets defined as a combination of the regional and the occupational dimensions. To the best of our knowledge, we provide the first empirical evidence on the simultaneous influence of regional and occupational spillovers on job matching.

We compute regional and occupational spillovers by computing the sum of stocks of unemployed and vacancies across all labor markets weighted by their regional proximity and occupational similarity. In total, we define three types of spillovers: regional spillovers given by the vacancies and unemployed in nearby regions, occupational spillovers given by vacancies and unemployed in similar occupations, and, lastly, combined regional and occupational spillovers given by vacancies and unemployed from nearby regions and similar occupations. We incorporate these spillovers into the specification for an empirical matching function that relates inflows into employment in a local labor market to vacancies and unemployed in the same local labor market. Thus, in addition to the direct matching elasticities of unemployed and vacancies that are observed on the same local labor market like the inflows in employment, we estimate the influence of spillover effects.

Our results reveal sizeable and significant direct matching elasticities and spillover effects. In particular, we find positive regional spillover effects of both unemployed and vacancies in the nearby regions and positive occupational spillover effects of vacancies in similar occupations. In contrast, we find a negative occupational spillover effect of unemployed in similar occupations; this can be explained by the negative effect of the number of unemployed on their individual probability to find a job. However, this adverse effect is overbalanced by the positive influence of regional spillovers. We also find relative small positive combined occupational and regional spillover effects. In sum, the results suggest that local labor markets are susceptible to penetration, especially between nearby local areas. Therefore, we conclude that the estimates of the direct matching elasticities in local and occupational labor markets are biased if regional and occupational spillovers and their combination are neglected.

The presented evidence motivates future research on the multidimensional nature of labor mobility that may create competition in local labor markets. For instance, penetrability of the borders as well as symmetry of the mutual affectedness of local labor markets by each other are a matter worthy of further exploration.

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A Model of Non-sequential Search

The "bulletin board" model proposed by Hall (1979) and Pissarides (1979) describes non-sequential job search. In the following, we combine the version by Burda/Profit (1996), which incorporates the influence of the unemployed and vacancies from nearby local labor markets, with the version by Stops (2014a), which considers mobility between different occupational markets. Thus, our model is able to explain the possible direct and indirect effects of the number of unemployed and vacancies in nearby local areas and similar occupations.

Consider an economy that is divided into L local areas, where it is possible to be employed in one of I occupations. The local areas and occupations are indexed by $l = 1, \ldots, L$ and $i = 1, \ldots, I$. Within each local area l and occupation i there are u_{il} identical unemployed workers and v_{il} identical firms. Each firm searches for one worker to employ. In the center of each local area, there is an employment office that gathers information on all vacancies in all occupations and local areas, which then brings workers and firms together. All offices receive and publish the same information at the same time, due to, e.g., the existence of supra-regional Internet-based information services. The unemployed workers apply for jobs in their occupation i or in another occupation $j \neq i$, the application can be sent either to the employment office in their residence local area l or to another local area $m \neq l$. Moreover, the workers decide about their search intensity N_{ijlm}, which can be measured by the number of applications sent for each occupation to each regional employment center.

Each application is a random draw and is associated with search costs $c + aD_{lm} + bD_{ij}$, where c, a and b are positive constants. D_{lm} is the distance between the employment offices in the local areas l and m. D_{ij} is the content dissimilarity between the current occupation of the unemployed and the occupation she applies for. Thus, the search costs linearly depend both on the net costs of applying to different local areas, as well as on the costs of gathering information to apply to another occupation. The search costs are minimum ($= c$) if an application is made within the current local area of residence and the current occupation, i.e., $D_{lm} = 0$ and $D_{ij} = 0$.

Following a successful search, the worker is employed in local area m in occupation j and receives wage w. The interest rate in the economy is r, such that the real wage is equal to w/r.

Given the current geographical location of the worker l and her current occupation i, she decides on the number of interviews in each local area m and occupation j. The worker knows about the probability, f_{jm}, of getting a job in local area m and occupation j. The decision on the optimal number of interviews is yielded from maximization of net total expected benefit from the search:

$$\underbrace{\left[1 - (1 - f_{jm})^{N_{ijlm}}\right] \frac{w}{r}}_{\text{total expected benefit}} - \underbrace{N_{ijlm}(c + aD_{lm} + bD_{ij})}_{\text{costs}} \xrightarrow[N_{ijlm}]{} \max \tag{10}$$

The first term in equation (10) refers to the total expected benefit of a job match between

a worker in local area l and occupation i and a vacancy in local area m and occupation j. For simplicity, we assume that unemployment does not yield any income. Furthermore, workers' search costs are assumed to be relatively small compared with expected returns to search. This implies that income effects from searches for jobs in the other local labor markets can be neglected and, therefore, workers can separately fix their optimal search intensities for each local labor market.

Solving for the optimal search intensity N^*_{ijlm} yields:

$$N^*_{ijlm} = \begin{cases} f_{jm}^{-1} \cdot \ln\left(\frac{f_{jm}\frac{w}{r}}{c+aD_{lm}+bD_{ij}}\right) & \text{if } f_{jm}\frac{w}{r} \geq c + aD_{lm} + bD_{ij}, \\ 0 & \text{otherwise.} \end{cases} \tag{11}$$

Thus, the optimal search intensity is a positive function of the ratio of expected gains and the search costs $f_{jm}\frac{w}{r}\Big/(c + aD_{lm} + bD_{ij})$. Further derivations show that the optimal search intensity is increasing in wages, while decreasing in interest rate, in application fixed costs, and in the introduced distance parameters.

Taking partial derivative with respect to f_{jm} yields:

$$\frac{\partial N^*_{ijlm}}{\partial f_{jm}} = f_{jm}^{-2}\left[1 - \ln\left(\frac{f_{jm}\frac{w}{r}}{c + aD_{lm} + bD_{ij}}\right)\right]. \tag{12}$$

It follows from equation (12) that the optimal search intensity N^*_{ijlm} is decreasing in the probability to find a job in another local area f_{jm} if the expected benefits are much higher than the costs of search:

$$\frac{\partial N^*_{ijlm}}{\partial f_{jm}} < 0 \quad \text{if} \quad f_{jm}\frac{w}{r} \gg c + aD_{lm} + bD_{ij}. \tag{13}$$

With the optimal intensity of search N^*_{ijlm}, the unconditional job finding probability for a local labor market in any local area and occupation can be defined. In the "bulletin board" type of model, the vacancy is filled if it is chosen by at least one worker. We assume that all vacancies in all regions and occupations are known by all job searchers, due to the bulletin board (here, it is allowed that $i = j$ and $l = m$):

$$V_{jm} = V = \sum_{j=1}^{J}\sum_{m=1}^{M} v_{jm}. \tag{14}$$

If at least one worker chooses a vacancy, then, according to the "bulletin board" type of model, this vacancy is filled. After all unemployed make their optimal number of applications in each occupation and local area ($U_{jm} \equiv \sum_{i=1}^{I}\sum_{l=1}^{L} N^*_{ijlm}u_{il}$), the probability of a particular vacancy not being chosen is equal to:

$$\prod_{i=1}^{I}\prod_{l=1}^{L}\left[\prod_{k=1}^{N^*_{ijlm}}\left[1-(V_{jm}-k+1)^{-1}\right]\right]^{u_{il}} \approx \prod_{i=1}^{I}\prod_{l=1}^{L}\left[\prod_{k=1}^{N^*_{ijlm}} e\right]^{-\frac{u_{il}}{V_{jm}}} = \exp\left(-\frac{U_{jm}}{V_{jm}}\right). \tag{15}$$

Consequently, the unconditional job finding rate for each interview that is held in the targeted occupation j and the targeted local area m, is defined as the number of vacancies per job seeker weighted by their job finding probabilities:

$$f_{jm} = \frac{V_{jm}}{U_{jm}}\left[1-\exp\left(-\frac{U_{jm}}{V_{jm}}\right)\right]. \tag{16}$$

Based on the previous calculations, the number of exits of unemployed into employment from occupation i and local area l, is defined as the number of vacancies per job seeker weighted by their job finding probabilities:

$$x_{il}(\mathbf{u},\mathbf{v}) = u_{il}F_{il} = u_{il}\left[1-\prod_{j=1}^{J}\prod_{m=1}^{M}(1-f_{jm})^{N^*_{ijlm}}\right], \tag{17}$$

where $\mathbf{u}$ and $\mathbf{v}$ are the vectors of stocks of unemployed and vacancies in all local areas and all occupations. F_{il} is the probability that an unemployed individual in occupation i and local area l receives at least one job offer.

This function of matches involves the unemployed and vacancies in all occupations and all local areas, giving rise to the possible regional and occupational spillovers:

$$\frac{\partial x_{il}}{\partial u_{il}} = F_{il} + u_{il}\cdot\frac{\partial F_{il}}{\partial u_{il}}. \tag{18}$$

$$\frac{\partial x_{il}}{\partial u_{jm}} = u_{il}\cdot\frac{\partial F_{il}}{\partial u_{jm}}; i\neq j \text{ and } m\neq l \tag{19}$$

$$\frac{\partial x_{il}}{\partial v_{jm}} = u_{il}\cdot\frac{\partial F_{il}}{\partial v_{jm}}; \text{ for all } j,m \tag{20}$$

According to equation (18), the direct effect of an increase of the unemployed stock in a local labor market, il, on the exit of unemployed into employment in the same local labor market is positive, which is a common finding in the literature on job matching. The equations (19) and (20) show us that exits into employment in occupation i and local area l are also influenced both by the stock of unemployed and vacancies in other occupations $i\neq j$ and other local areas $l\neq m$. It can be further shown that the sign of $\frac{\partial F_{il}}{\partial u_{jm}}$ depends on the sign of $\frac{\partial f_{jm}}{\partial u_{jm}}$, which determines the direct positive effect of the unemployed on the number of matches. At the same time, there is an indirect effect through N^*_{ijlm}, which can be shown to be negative under specific conditions. Thus, the model documents the

relevance of occupational and regional spillovers. Nevertheless, the signs of their effects can be positive or negative and should be evaluated empirically.

B Construction of the occupational segments

Table 3: Assignment of the occupational orders to the occupational segments (Matthes et al., 2008)

Occupational segment		Occupational group (KldB 88)	
Code	**Name**	**Code**	**Name**
101	"Green" occupations	11	Farmers
		12	Winegrowers
		21	Livestock farmer
		22	Fish farmer
		31	Agricultural production manager
		32	Agricultural engineers and advisors
		41	Mixed crop and livestock farm laborers
		42	Livestock and dairy producers
		44	Pet groomers, animal care workers and related occupations
		51	Gardeners, horticultural and nursery growers
		52	Garden and landscape architects and administrators
		53	Florists
		61	Forestry production managers, foresters and huntspersons
		62	Forestry laborers
		421	Wine coopers and other wine-processing operators
		422	Brewers, maltsters and other brewer machine operators
		423	Other beverage makers, coffee-processing-machine operators, tasters and graders
		424	Tobacco preparers, products makers
201	Miner/chemical occupations	71	Miners
		72	Mining shot firers and blasters
		81	Stone crushers
		82	Earth, gravel and sand quarry workers
		83	Gas and crude oil quarry workers
		91	Mineral and stone processing plant operators
		141	Chemical products plant and machine operators
		142	Chemical laboratory workers
		143	Rubber products machine operators
		144	Tire vulcanizers
		151	Plastic products machine operators
		464	Shot firers and blasters except mining shot firers
		541	Power production plant operators
		542	Winding-, conveyor- and ropeway-machine operators
		547	Machine maintenance operators, machinists' assistants
		548	Boilerpersons, incinerators and related plant operators
		604	Cartographers and survey engineers
		605	Mining, metallurgy, foundry engineers
		624	Survey engineering technicians
		625	Mining, metallurgy, foundry engineering technicians
		626	Chemical and physical engineering technicians
		631	Agronomy, forestry and life science technicians
		632	Physical and mathematical science technicians

continued on the next page

Occupational segment		Occupational group (KldB 88)	
Code	Name	Code	Name
		633	Chemical science technicians
202	Glass, ceramic, paper production	111	Brick-maker and other stoneware makers
		121	Ceramics plant operators
		131	Frit makers, glass vitrifiers
		132	Hollow glassware makers
		133	Flat glass makers
		134	Gaffer
		135	Glass cutters, grinders and refiners
		161	Pulp and cellulose plant operators
		162	Packaging makers
		163	Bookbinding workers
		164	Other paper products machine operators
		171	Type setters, pre-press workers
		172	Stereotypers and electrotypers
		173	Book printers, letterpress
		174	Flat screen, gravure and intaglio printers
		175	Special, silk-screen printers
		176	Hecto- and mimeo-graphers
		177	Printer's hands
		514	Glass, ceramics and related decorative painters, glass engravers and etchers
		634	Photo laboratory technicians
		837	Photographers, camera and retouching operators
203	Textile, leather production	331	Spinner, fibre-preparer
		332	Spoolers, twisters, rope-makers
		341	Weaving- and knitting-machine preparers
		342	Weavers and weaving-machine operators
		343	Tufted textile-, fur- and leather-products makers
		344	Knitters and knitting-machine operators
		345	Felt and hat body makers
		346	Textile braiders
		351	Tailors and dressmakers
		352	Sewers and sewing-machine operators
		353	Lingerie tailors and sewers
		354	Embroiderers
		355	Hatters and cap makers
		356	Sewer and sewing-machine operators otherwise undisclosed
		357	Other textile-products makers
		361	Textile dyer and dyeing-machine operators
		362	Textile bleaching-, cleaning-machine operators and other finishers
		371	Tanners, cutgut string makers and other leather-preparing-machine operators
		372	Shoe-makers
		373	Shoemaking-machine operators
		374	Saddlers, truss makers and other coarse-leather-products makers
		375	Purse, hand bag and other fine-leather-products makers
		376	Leather garment makers and other leather-products machine operators
		377	Leather glove makers
		378	Pelt dressers, furriers and other fur-products makers
		543	Pump-, compressor-, assembly line-, boring and other machines operators
		549	Machine-tool setters and setter-operators no further specified
		627	Other production technicians
		629	Forepersons and other operations managers
		931	Launderers and ironers

continued on the next page

Occupational segment		Occupational group (KldB 88)	
Code	Name	Code	Name
		932	Textile cleaner, dyers, chemical purifiers
204	Metal producer	191	Ore and metal furnace operators, metal melters
		192	Rolling-mill operators
		193	Metal drawers and extruders
		201	Moulders and coremakers
		202	Casters
		203	Casters of semi-finished products and other mold casters
		211	Sheet metal pressers, drawer and puncher
		212	Wire moulder, cable splicers
		213	Other metal moulders non cutting deformation
		221	Metal lathe operators
		222	Metal milling cutters
		223	Metal planers
		224	Metal borers
		225	Metal grinders
		226	Other metal-cutting occupations
		231	Metal polishers
		232	Engravers, chasers
		233	Metal finishers
		234	Galvanizers, metal colorers
		235	Enamelers, zinc platers and other metal surface finishers
		241	Welder, oxy-acetylene cutters
		242	Solderers
		243	Riveters
		244	Metal bonders and other metal connectors
		251	Steel-, black-, hammer-smiths and forging press workers
		252	Tank and container builders, coppersmiths and related occupations
		261	Tinsmiths
		262	Plumbers
		263	Pipe and tube fitters
		270	Locksmiths and fitters, not further specified
		271	Building fitters
		272	Sheet metal worker, plastics fitters
		273	Engine fitters
		274	Plant and maintenance fitters
		275	Steel construction fitters, steel ship builders
		281	Motor vehicle repairers
		282	Agricultural machinery repairers
		283	Aircraft mechanics
		284	Precision mechanics
		285	Other mechanics
		286	Watch-, clock-makers
		291	Toolmakers, instrument mechanics
		301	Precious fitters otherwise undisclosed
		302	Precious metal smiths
		303	Dental technicians
		304	Opthalmic opticians
		323	Metal plant operators no further specification
		502	Pattern and mold carpenters
		601	Mechanical and automotive engineers
		621	Mechanical engineering technicians
		686	Filling station attendants
205	Electricians	311	Electrical fitters, mechanics
		312	Telecommunications mechanics, craftsmen
		313	Electric motor, transformer fitters
		314	Electrical appliance fitters
		315	Radio, sound equipment mechanics
		321	Electrical appliance and equipment assemblers

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Occupational segment		Occupational group (KldB 88)	
Code	**Name**	**Code**	**Name**
		322	Metal-, rubber-, plastic-, paperboard-, textile and related products assemblers
		602	Electrical and electronics engineers
		622	Electrical, electronics and telecommunications engineering technicians
		774	Computer scientists, equipment operators, computing and data processing professionals
206	Wood occupations	181	Wood-processing-plant operators
		182	Woodworking machine setters and setter-operators, and appropriate occupations
		183	Wood products, brush-, cork-maker
		184	Basketry weavers and wicker worker
		305	Musical instrument makers
		306	Doll, model makers, taxidermists
		485	Glaziers
		501	Cabinetmakers, carpenters and joiners
		503	Cartwrights, wheelwrights, coopers and tubbers
		504	Other wood-products makers, Boat-, glider- and wooden sports-equipment-building experts
		512	Goods painters and varnishers
		513	Wood surface finishers, veneers
207	Construction	112	Cement and concrete block makers
		441	Bricklayers ans masons
		442	Steel fixers, concreters
		451	Carpenters
		452	Roofers
		453	Scaffolders
		461	Paviors, pavers
		462	Road building experts
		463	Track building experts
		465	Land improvement, maintenance and hydraulic structure building experts
		466	Well, duct and other civil engineering building experts
		471	Earth-moving laborers
		472	Building construction labourers and other construction and maintenance laborers otherwise undisclosed
		481	Stuccoers, plasterers
		482	Insulators and proofers
		483	Tile setters
		484	Stove setters and air heating fitters
		486	Composition floor and terrazzo layers
		491	Interior decorators, carpet and parquet layers
		492	Upholsterers, mattresses makers
		511	Construction painters, wall-paperers, varnishers
		544	Crane and hoist plant operators
		545	Earth-moving and related plant operators
		546	Construction plant operators
		603	Architects, civil and structural engineers
		623	Civil engineering technicians
		635	Draftspersons
		716	Construction and maintenance laborers: roads, dams, bridges and similar constructions
		836	Interior architects, visual merchandiser
301	Hotel/restaurant occupations	391	Bakers and baked-goods, cereal- and chocolate-products machine operators
		392	Pastry-cooks and confectionery makers
		401	Butchers and stickers
		402	Meat- and sausage-processing-machine operators
		403	Fish-processing-machine operators
		411	Cooks

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Occupational segment		Occupational group (KldB 88)	
Code	Name	Code	Name
		412	Ready-made meals-, fruit- and vegetable-processing-machine operators
		431	Dairy-products machine operators, butter-, lard- and margarine makers
		432	Grain- and spice-milling-machine operators
		433	Sugar-production machine operators, chocolate, sweets and ice-cream makers
		702	Travel agency clerks, attendants, stewards, consultants, organizers and guides
		805	Disinfectors, morticians, meat and and other health inspectors
		911	Hoteliers, innkeepers, restaurateurs and management assistants in hotels and restaurants
		912	Waiters, waitresses, stewards, stewardesses and buspersons
		913	Porters, bartenders and other hotel and restaurant attendants
		921	Housekeepers and related workers
		922	Energy and other consumer advisors
		923	Valets, chambermaids and other housekeeping attendants
		933	Dishwashers, room and domestic cleaners
		934	Windows, frontages and buildings cleaners
		935	Sweepers, streets and sewerages cleaners, dustmen and other waste disposal workers
		936	Car washers, vehicle cleaners, car and vehicle carers
		937	Machinery, plant, tube and container cleaners
302	Storage/ transport occupations	521	Products testers, sorters otherwise undisclosed
		522	Product packagers, balers, wrappers, qualifiers and other loading agents
		701	Logistics managers and transport clerks
		711	Locomotive engine, tram and subway drivers
		712	Railway brake, signal and switch operators, shunters and railway guards and conductors
		713	Other brake, signal and switch operators, transport guides and conductors, fleet managers
		714	Car, taxi, bus, (heavy) truck and other motor vehicle drivers
		715	Cabby
		721	Navigators, nautical ships' officers and pilots
		722	Technical ship's officers, engineers, technicians and machinists
		723	Seagoing ships' deck crews
		724	Inland boatmen and related ships' decks crews
		725	Ferrymen, lock-masters, coastguards and other water traffic occupations
		726	Aircraft pilots, flight engineers and other air traffic occupations
		732	Mail carriers, sorting clerks, porters and deliverers
		733	Radio operators
		741	Stocks administrators and clerks
		742	Lift, lifting-trucks and other materials handling equipment operators
		743	Longshoremen, furniture removers
		744	Stock, loading and other transport workers
303	Merchandise occupations	681	Wholesaler, retail salespersons and buying agents
		682	Shop, stall and market salespersons and demonstrators
		683	Publishers, management assistants in publishing and booksellers
		684	Chemists in drugstores

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Occupational segment		Occupational group (KldB 88)	
Code	Name	Code	Name
		685	Chemist's assistants in pharmacies
		687	Commercial sales representatives and sales agents
		691	Banking experts including tellers, finance clerks as well as finance dealers and brokers
		692	Building society experts including representatives as well as clerks
		693	Health insurance experts including representatives as well as clerks, not social security
		694	Life, property insurance experts including representative as well as clerks
		704	Finance, stock, trade, ship, real estate, insurance brokers
		705	Landlords, hirers, agents, bookers, auctioneers
		706	Cashiers, ticket agents, Debt- and vending-machine money collectors and ticket inspectors
		773	Cashiers and ticket clerks
		855	Dietitians, nutritionists and pharmacy technicians
		901	Hairdressers, barbers, wig-makers and related workers
		902	Beauticians, manicurists, pedicurists and related workers
304	White collar worker	703	Advertising and public relations experts
		734	Telephone switchboard operators
		751	Entrepreneurs, managing directors and division managers
		752	Management, personnel and other business consultants
		753	Financial, tax accountants and accounting clerks
		762	Senior and administrative state officials
		763	Senior and administrative officials of humanitarian and other special-interest organizations
		771	Calculators, calculating and counting clerks
		772	Bookkeepers
		781	Office clerks, otherwise undisclosed
		782	Secretaries, stenographers and typists
		783	Data entry operators
		784	Scribes and other office hands
		811	Judges and prosecutors
		812	Law officers
		813	Lawyers, notaries, legal representatives, advisors and other legal professionals
		814	Executory officers, prison guards
		863	Housemasters, social pedagogue, deacons
		881	Economists, psychologists, sociologists, political scientists, statisticians
305	Security occupations	607	Industrial and other operating engineers
		628	Industrial and other operating technicians
		791	Factories security offices, store, hotel and other detectives
		792	Watchpersons, custodians, attendants and related workers
		793	Door-, gatekeepers and caretakers
		794	Menials, bellmen, ushers and groundkeepers
		801	Soldiers, border guards, police officers
		802	Firefighters
		803	Safety inspectors, trade controllers, gauging, and environmental protection officers
		804	Chimney sweepers
306	Social/care occupations	861	Social work, welfare, health care professionals and workers; geriatric nurses
		862	Housemasters, social pedagogue, deacons

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Occupational segment		Occupational group (KldB 88)	
Code	**Name**	**Code**	**Name**
		864	Kindergarten teachers, child care workers and pediatric nurses
		891	Bishops, pastors, chaplains and other religious professionals
		892	Nuns, friars and other religious associate professionals
		893	Sextons, cantors and other religious assistants
307	Medical occupations	851	Non-medical practitioners, psychotherapists
		852	Masseurs, physiotherapists and health care professionals
		853	Nurses, midwifes, nursing and midwifery associate professionals
		854	Paramedics and nursing auxiliary workers
		856	Doctor's receptionists and assistants
		857	Medical technical, laboratory, radiological assistants
308	Doctors	841	Medical doctors
		842	Dentists
		843	Veterinaries
309	Teacher	871	University, college professors and related teaching professionals
		872	Grammar school teacher and related teaching professionals
		873	Primary, secondary school, special education teachers and related teaching professionals
		874	Vocational, professional college teachers and related teaching professionals
		877	Driving, flying, hygienic and other instructors, otherwise undisclosed
310	Artists/Athletes	101	Stone splitters, cutters and carvers
		102	Precious-stone workers, jewel preparers
		831	Composers, music directors and musicians
		832	Film, stage and related directors, actors, singers and dancers
		833	Sculptors, painters, graphic and related artists
		834	Decorators, sign painters
		835	Set designer, light board, image and sound recording engineers, technicians and operators
		838	Clowns, magicians, acrobats, professional sportspersons, mountain guides and models
		875	Art, music and voice teachers and related teaching professionals, otherwise undisclosed
		876	PE teachers, related teaching professionals, skiing and other sports instructors
311	Natural scientists	606	Other production engineers
		611	Chemists, chemical engineers
		612	Physicists, physics engineers, mathematicians
		844	Pharmacists
		883	Biologists, geographers, meteorologists and other natural scientists, otherwise undisclosed
312	Humanities scholars	821	Authors, journalists, editors and announcers
		822	Interpreters, translators
		823	Librarians, archivists, documentalists, curators, library and filing clerks
		882	Philologists, historians, philosophers and other humanities scientists, otherwise undisclosed
999	Others	531	Helper no further specified
		982	Threshold workers, volunteers with occupation still to be specified
		983	Job-seekers with occupation still to be specified

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