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Sequential versus Non-Sequential Search among German Employers – Evidence from a Job Vacancy Survey

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Abstract

In this note, we provide evidence on the extent and determinants of sequential versus non-sequential search among German employers. Using unique representative data on employers' recruitment behavior, we exploit direct information on whether employers first formed a pool of applicants from which they chose the most suitable candidate (Non- Sequential Search), or whether they hired the first suitable applicant (Sequential Search). We show that non-sequential search is the predominant search strategy, accounting for about 75 per cent of all successful hirings. Hirings by larger employers and those for high- skilled positions are disproportionately represented among the non-sequential search processes. We then proceed to decompose recruitment durations for non-sequential search into an application and a selection period and, for sequential search, into an information and combined application/selection period. With non-sequential search, the application period lasts, on average, about 18 days, whereas the selection period is 45 days long. Sequential search processes on start with a very short period of about one day until the very first application arrives, followed by a rather long combined application/selection period of 57 days until a suitable applicant is found.

Zusammenfassung

Wir untersuchen das Ausmaß und die Determinanten sequenzieller versus nicht sequenzieller Suche unter deutschen Arbeitgebern. Auf Basis repräsentativer Daten über das Einstellungsverhalten von Betrieben nutzen wir direkte Informationen darüber aus, ob Betriebe zunächst einen Pool von Bewerbern gebildet haben, aus denen sie den am besten geeigneten Bewerber auswählen (Nicht Sequenzielle Suche), oder ob sie den ersten geeigneten Kandidaten eingestellt haben (Sequenzielle Suche). Wir zeigen, dass die nicht sequenzielle Suche die vorherrschende Suchstrategie ist, auf die etwa 75 Prozent aller erfolgreichen Einstellungen entfallen. Einstellungen in größeren Betrieben und für hochqualifizierte Positionen erfolgen überproportional häufig auf Basis nicht sequenzieller Suchprozesse. Anschließend werden die Rekrutierungsdauern für die nicht sequenzielle Suche in eine Bewerbungs- und eine Auswahlphase und für die sequenzielle Suche in eine Informations- und kombinierte Bewerbungs-/Auswahlzeitphase zerlegt. Bei nicht sequenzieller Suche dauert der Bewerbungszeitraum im Durchschnitt etwa 18 Tage, während der Auswahlzeitraum 45 Tage beträgt. Sequenzielle Suchprozesse beginnen mit einem sehr kurzen Zeitraum von etwa einem Tag, bis die erste Bewerbung eintrifft, gefolgt von einer längeren kombinierten Bewerbungs-/Auswahlfrist von 57 Tagen, bis ein geeigneter Bewerber gefunden ist.

JEL classification

J63

Keywords

Employers' Search, Vacancy Data, Recruitment Durations

1 Introduction

The question of whether employers search sequentially or non-sequentially is of key importance for the nature of search frictions. When searching sequentially, employers receive applications one-by-one and decide upon arrival whether to hire the applicant. Non- sequential search, in contrast, involves employers first forming a pool of applicants, from which they select the most suitable candidate afterwards. The few available studies suggest that employers' search is mostly non-sequential (see e.g. van Ours and Ridder 1992, 1993; Abbring and van Ours 1994). Which of the two strategies provides the more appropriate description of employers' search strategies has important implications for the interpretation of recruitment durations. With non-sequential search, recruitment periods are to a greater extent selection periods than with sequential search. The reason is that selection from a pool typically involves the comparison of several applicants. The decomposition of recruitment durations into an application and selection period matters, for instance, for the sensitivity of recruitment durations with respect to labour market tightness. Moreover, many institutional changes, such as changes in the strictness of employment protection, are likely to impact upon both sub-periods in different ways. For example, while tighter employment protection is likely to prolong the selection period, it may shorten the application period, if employers subject to tighter employment protection become more attractive for applicants.

In this note, we add to the small literature on employers' search strategies, using data from the IAB Job Vacancy Survey. Previous studies have inferred employers' search strategies either from the evolution of the applicant arrival and vacancy hazard rate (van Ours and Ridder 1992; Abbring and van Ours 1994), or from the elasticity of the number of rejected applicants with respect to the number of vacancies (van Ommeren and Russi 2014). Unlike this literature, our study can directly exploit survey information on whether employers first formed a pool of applicants from which they chose the most suitable candidate, or whether they hired the first suitable applicant. Based on this information, we decompose recruitment durations for non-sequential search into an application and a selection period and, for sequential search, into an information and combined application/selection period.

2 Data and Methods

2.1 Data Description

The data we use for our empirical analysis stem from the *IAB Job Vacancy Survey* (Kubis, Moczall, and Rebien 2017). The representative survey is based on a repeated annual cross-section of German establishments. The data are available from 1989 onwards, with the most recent waves covering about 13,000 establishments. The data are ideally suited for exploring employers' search: First, the surveyed establishments provide information on their most recent hiring process. For this recruitment process, establishments were explicitly asked to report their search strategies. The precise question was "Following which strategy did you decide on this specific applicant?", with possible answers being "We collected applications and chose

the best suited applicant" (*Non-Sequential Search*), *or* "We decided in favour of the first suitable applicant" (*Sequential Search*). As this information is available only for 2015, we restrict our sample to this year. Second, additional information includes characteristics of the hired employee, characteristics of the specific position to be filled, and precise information on the recruitment duration, i.e. the duration from the start of search until the decision for an applicant.

2.2 Descriptives

From the 2015 wave, we keep all establishments who experienced a hiring process within the last twelve months. Restricting the sample to establishments without any missing values in our main variables of interest results in a sample of 4,282 establishments. Table 1 displays the share of hirings following sequential search cross-tabulated by industry and size classes. The (weighted) figures indicate that non-sequential search accounts for about 75 per cent of all successful hirings. Sequential search is particularly prevalent in agriculture and the transport industry, with shares of 46 and 39 per cent, respectively. Non-sequential search is the predominant strategy in public administration, the chemical industry as well in financial services. The strategies' prevalence also varies greatly across size classes: While non-sequential (sequential) search accounts for 92 (8) per cent of all hirings in larger establishments, the fraction amounts to about two thirds (one third) of hirings in small establishments. Table 2 provides further descriptives on selected attributes of the hiring process. The weighted figures show that hirings of high-skilled workers account for 22 per cent of those following non-sequential search, but only 13 per cent of those following sequential search. The recruitment duration with non-sequential search lasts with 61 days six longer than with sequential search. Moreover, consistent with what has been found earlier (van Ommeren and Russi 2014), the use of social contacts is more relevant for sequential search. For hirings following non-sequential search employers report to have spent, on average, almost twice as many hours (21 hours) as for hirings based on sequential search (13 hours). Moreover, when searching non-sequentially employers receive on average eight suitable applications, whereas with sequential search they report to have attracted two suitable candidates. The number of applicants who were interviewed following non-sequential search is – as expected – with five applicants larger than that following sequential search (three applicants).

Table 1: Share of recruitments following a sequential strategy by industry and firm size

	Number of employees			
Industry	1-49	50-249	250+	Total
Agriculture, forestry[5]	0.494	0.271	*	0.457
Mining/ores/earths[5]	0.235	0.360	0.127	0.252
Nutrition, textiles, clothing, furniture etc.[1]	0.305	0.251	0.084	0.208
Wood, paper, printing[1]	0.294	0.238	0.000	0.190
Chemistry/plastics/glass[1]	0.322	0.024	0.015	0.071
Metals, metal production[1]	0.236	0.282	0.069	0.197
Machines/electronics/vehicles[1]	0.361	0.360	0.018	0.181
Energy utilities[2]	0.208	0.067	0.126	0.123
Water, waste management[2]	0.264	0.031	0.000	0.115
Construction[1]	0.332	0.274	0.239	0.319
Trade, retail, repairs[2]	0.343	0.070	0.236	0.256
Transport, warehouses[2]	0.457	0.527	0.000	0.389
Hospitality[2]	0.302	0.208	0.139	0.259
Information/communication[2]	0.252	0.320	0.170	0.261
Financial services, insurance[2]	0.138	0.026	0.019	0.073
Real estate[2]	0.079	0.239	0.000	0.102
Liberal professions[2]	0.435	0.099	0.042	0.233
Other commercial services[2]	0.226	0.463	0.192	0.261
Temporary employment agencies[3]	0.328	0.265	0.098	0.234
Public administration[4]	0.054	0.009	0.040	0.033
Education, child care[4]	0.255	0.165	0.032	0.135
Health and social services[4]	0.308	0.187	0.070	0.167
Art, entertainment, recreation[2]	0.300	0.220	0.000	0.231
Other services[2]	0.196	0.145	0.023	0.148
Total	0.320	0.238	0.079	0.220

[1]Manufacturing, [2]Services, [3]Temporary Employment Agencies, [4]Public Sector, [5]Others

*Value not shown for data protection reasons (because of a too small number of observations).

Source: IAB Job Vacancy Survey, wave 2015 (weighted). Industry groups in later tables:

Table 2: Selected attributes of recruitments by search strategy

	Weighted		Unweighted	
Sequential search?	No	Yes	No	Yes
Required skill level: Low-skilled (%)	18.9	30.0	11.1	21.7
Required skill level: Medium-skilled (%)	59.2	57.5	67.1	66.4
Required skill level: High-skilled (%)	21.9	12.5	21.8	12.0
Average recruitment duration (days)	60.5	54.7	62.9	58.6
Search channel: Social contacts (%)	41.3	70.4	37.3	64.2
Hours spent on search (#)	20.7	13.1	21.2	12.7
Suitable applicants (#)	7.7	1.9	5.4	2.0
Applicants invited for interview (#)	5.0	2.7	4.2	1.9

Source: IAB Job Vacancy Survey, wave 2015. The medium (high) skill requirement refers to a vocational training (college degree).

2.3 Decomposition of Recruitment Durations

In what follows, we adopt the procedure proposed by Abbring and van Ours (1994), in order to decompose the recruitment duration into two subsequent periods. For non-sequential search, the first period will be referred to as the application period and the second one as the selection period. With sequential search, the second period covers a combined application and selection period, whereas the first period may be interpreted as a period during which information about the vacancy becomes available to potential applicants.[1]

According to this decomposition, the recruitment duration is modelled as a two-stage exponentially distributed process. It is assumed that the first period, A, is exponentially distributed with hazard rate λ. The hazard rate is exponentially specified, such that $\lambda = \exp(X \cdot \beta + v_1)$, where X represents a vector of observables and v_1 a heterogeneity term. The conditional distribution of the first period is then given by $f_{A|v_1}(a) = \lambda \, exp(-\lambda \, a), if \; a \geq 0$ and 0 otherwise.

Let B denote the second period. The joint distribution of the overall duration $T = A + B$ along with A derives from multiplying the conditional distribution of the first period, A, with that of T, conditionally on having observed A. The latter is given by $f_{T|A, v_2}(t|a) = \theta \cdot exp(-\theta \cdot (t - a)), if \; t \geq a$ and 0 otherwise. As with λ, the hazard rate θ of the second period is specified exponentially, such that $\theta = exp(Z\gamma + v_2)$, with Z denoting a vector of observables and v_2 again representing a heterogeneity term. The simultaneous distribution of T and A reads as

$$f_{A,T|v_1,v_2}(a,t) = f_{T|A,v_2}(t|a) \cdot f_{A|v_1}(a) = \lambda \cdot \theta \cdot exp(-\theta \cdot t) \cdot exp(-(\lambda - \theta) \cdot a)$$

Integrating the joint distribution $f_{A,T|v_1,v_2}(a,t)$ over a yields the marginal distribution of T, for $\lambda \neq \theta$:

$$f_{T|v_1v_2}(t) \int_0^t fA,T|v_1,v_2(a,t)da = exp(-\theta \cdot t) \cdot \int_0^t (\lambda \cdot \theta \cdot exp(-\lambda - \theta) \cdot a))da \quad (1)$$

$$= \frac{\lambda \cdot \theta}{\theta - \lambda} \cdot (exp(-\lambda \cdot t) - exp(-\theta \cdot t)) \text{ if } t \geq a \text{ and 0 otherwise} \quad (2)$$

Assuming that v_1 and v_2 are jointly normally distributed, the sample likelihood reads as

$$L = \prod_{i=1}^{N} \int_{-\infty}^{\infty} \frac{\lambda \cdot \theta}{\theta - \lambda} \cdot (exp(-\lambda \cdot t) - exp(-\theta \cdot t)) f(v) \cdot dv \quad (3)$$

In what follows, we will provide estimates for two models, with and without unobserved heterogeneity. For both periods' hazard rates, X and Z include as covariates the log of the number of vacancies and unemployed at the federal state level (NUTS 1), three categories for skill requirements (low, medium and high-skilled), size class and industry dummyvariables.

3 Estimation Results

Table 3 displays the estimated coefficients of the covariates entering each period's hazard rate for our baseline specification without unobserved heterogeneity. The final row contains the estimates of each period's duration. The estimated coefficients refer to covariates determining the recruitment hazard, i.e. a positive value implies faster recruitment. As noted by Abbring

[1] Note that in our case, the substantive meaning of the first period differs somewhat from Abbring and van Ours' interpretation, as the authors' data are confined to vacancies notified to the Dutch public employment offices.

and van Ours (1994), the marginal distribution in eqs. (1) and (2) is symmetric in λ and θ, which makes it difficult to attribute the hazard rates to either the first or second period. To distinguish the periods from each other, the authors assign the larger hazard rate to the first period. This is based on the empirical pattern of their observed vacancy hazards, pointing to a shorter initial period during which no vacancies are filled, followed by a longer period during which the vacancy hazard rate becomes positive.

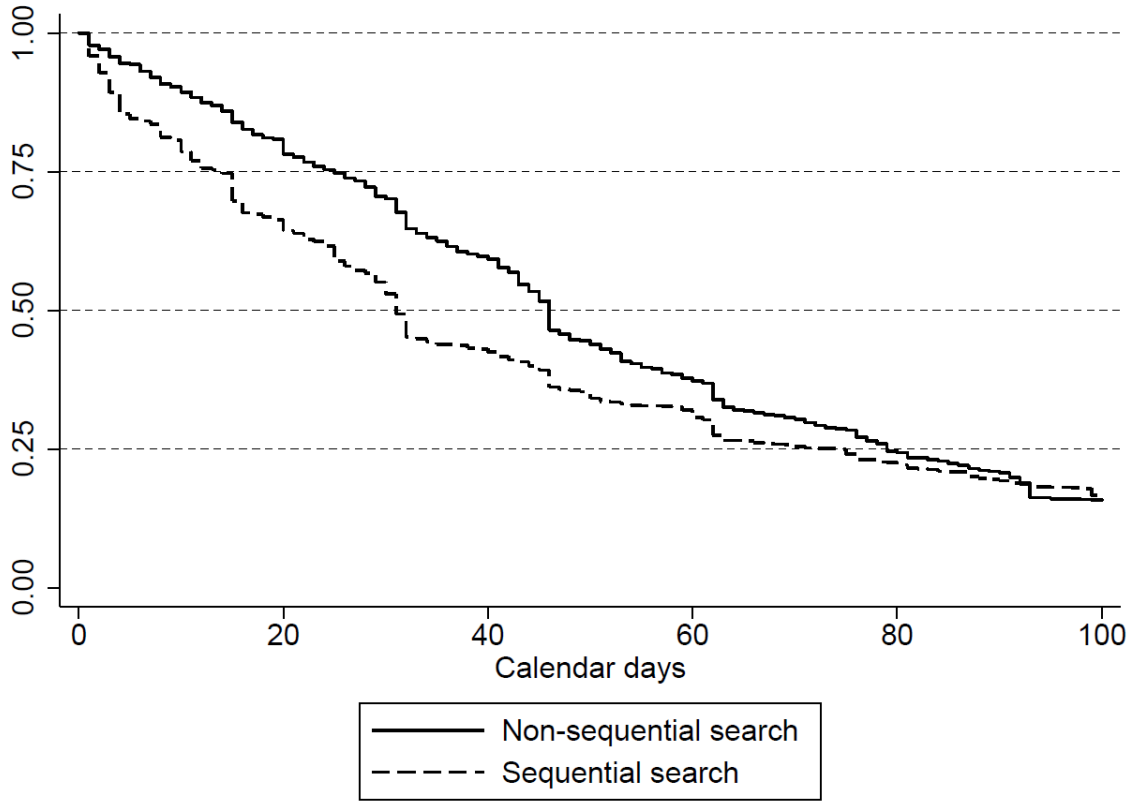
Table 3: Results from maximum likelihood estimation

Search Strategy	Non-sequential		Sequential	
Phase	Long	Short	Phase	Long
Content	Screening	Application	Content	Screening
Registered vacancies in federal state (ln)	0.126	-0.320	0.045	2.098 ***
	(0.092)	(0.209)	(0.061)	(0.524)
Registered unemployed in federal state (ln)	-0.127*	0.290*	-0.063	-1.143***
	(0.076)	(0.174)	(0.062)	(0.353)
Firm size: 50–249	0.089	-0.119	0.109	0.227
	(0.071)	(0.184)	(0.093)	(0.466)
Firm size: 250+	0.251**	-0.421***	0.265**	2.691***
	(0.099)	(0.132)	(0.132)	(0.577)
Industry: Services	0.139	-0.205	0.021	-6.331***
	(0.116)	(0.272)	(0.091)	(0.634)
Industry: Temporary Employment Agencies	0.292*	1.274	0.307**	-5.974***
	(0.152)	(1.300)	(0.148)	(0.881)
Industry: Public Sector	0.179	-0.126	0.290**	-4.594***
	(0.158)	(0.360)	(0.121)	(0.515)
Industry: Others	-0.045	0.127	0.168	-5.407***
	(0.104)	(0.678)	(0.182)	(0.972)
Required skill level: Medium-skilled	-0.030	-1.632*	-0.404***	1.103
	(0.088)	(0.943)	(0.071)	(1.178)
Required skill level: High-skilled	0.006	-2.131**	-0.184	-4.076***
(0.174)	(1.028)	(0.137)	(0.517)	
Constant	1.926***	4.519***	2.072***	7.838***
(0.136)	(0.737)	(0.237)	(1.840)	
Number of observations	3,285		997	
Log likelihood	2080.434		659.435	
Average estimated duration in days	45.239	17.670	57.355	1.264

Source: IAB Job Vacancy Survey, wave 2015. *Significance levels:* * 10 %, ** 5 %, *** 1 %. *Reference cat- egories:* Firm size: 1–49, Industry: Manufacturing, Required skill level: Low-skilled. Standard errors are in parentheses and are adjusted for clustering at the federal state level.

Figure 1 illustrates the pattern of the vacancy hazards in our data. After a very short period during which no vacancies are filled, sequential search processes begin with a great number of vacancies being filled very quickly. In contrast, the empirical pattern for non-sequential search is less clear-cut: Here the survival curve exhibits an initial modest decline in the survival probability, which then drops by a greater amount at around 20 days and then further at around 30 and 45 days. For non-sequential search, this pattern therefore does not allow us to infer the assignment of the hazard rates to either period from their relative durations.

Figure 1: Kaplan-Meier survival estimates of the recruitment duration by search strategy



Source: IAB Job Vacancy Survey, wave 2015, own calculations.

To distinguish the two periods from each other, we exploit our direct information on employers' search strategies and infer each period's substantive meaning from its estimated sensitivity to labour market tightness, separately for either strategy. For non-sequential search, we expect the length of the first (application) period to be more sensitive to labour market tightness than the second (selection) period. For non-sequential search, the figures indicate that the log of vacancies enters the shorter period's hazard equation with a negative coefficient. The log of unemployed, in contrast, enters the equation with a (weakly) significant and positive coefficient. Overall, this suggests a tighter labour market to raise the duration of the shorter period. In contrast, the sensitivity of the longer period's hazard rate to labour market tightness is found to be smaller, with the coefficients of the tightness mea- sures reversing their signs. Thus, the estimates indicate that for non-sequential search the shorter period represents the application period. For sequential search, the shorter (first) period's duration is negatively related to labour market tightness. This suggests that the period during which information about the vacancy disseminates is the shorter the more vacancies relative to unemployed are available.

As to firm size, with non-sequential search, large establishments experience a significantly longer application period. This may be due to larger employers having more formalized recruitment process with fixed application deadlines. At the same time, large employers incur shorter selection periods than their small counterparts. With sequential search, larger employers experience both, a shorter information dissemination and combined application/selection period. Turning to skills, with non-sequential search it takes longer to attract applications for medium and high-skilled positions, whereas skill requirements do not matter for the

length of the selection period. With sequential search, employers have to wait significantly longer until the very first application arrives for high-skilled as compared to low and medium-skilled positions. The combined application/selection period lasts significantly longer for medium-skilled positions.

For completeness, Table A 1 in the Appendix also reports the estimates incorporating un- observed heterogeneity. The variances are quite imprecisely estimated and the covariance of the heterogeneity terms is close to zero and insignificant. Overall, this model does not give rise to a notable improvement in the likelihood and yields very similar estimates as those in Table 3.

Taken together, our results show that non-sequential search begins with an application period that is two to three weeks long (18 days), followed by a selection period of about six weeks (45 days). Sequential search, in contrast, begins with a very short period of only one day until the very first application arrives, followed by a rather long combined application/selection period of 57 days until a suitable applicant is found.

4 Discussion

We studied recruitment durations using the IAB Job Vacancy Survey, which contains de- tailed information on employers' recruitment processes. A unique aspect of this survey is direct self-reporting of either sequential or non-sequential search. We document that non-sequential search is the predominant search strategy, thereby confirming the results of previous studies that have inferred employers' search strategies either from the evolution of the applicant arrival and vacancy hazard rate. Using the approach from Abbring and van Ours (1994), we decomposed the observed recruitment durations into two periods, separately for each strategy. Without imposing any restrictions on the estimated parameters, our results are highly consistent with what one would expect: for sequential search a very short initial period, in which information about a particular vacancy disseminates, and in the case of non-sequential search a much longer initial application phase during which applications are collected. For non-sequential search, the estimated application period's duration of two to three weeks is quite in line with usual application deadlines in German job advertisements. Overall, our results indicate that direct information on search strategies can be used to plausibly identify different parts of the recruitment process, even if no clear identifying pattern of vacancy hazards or information on applicant arrival rates is available.

Disclosure statement

Conflict of Interest: The authors declare that they have no conflict of interest.

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Appendix

Model with unobserved heterogeneity

The model with unobserved heterogeneity is estimated using simulation maximum likelihood methods. This involves drawing R values from the distribution of the unobserved heterogeneity term with variance-covariance matrix W and calculating, for each of these draws, the likelihood, which is then averaged over all draws. In particular, we assume that $v \sim N(0, W)$ and allow for an unrestricted variance-covariance structure of W. $With\ \lambda = exp(\beta X + v_1)\ and\ \theta = exp(\gamma Z_{.} + v_2)$ the simulated sample likelihood (SL) function is given by:

$$SL = \prod_{i=1}^{N} \frac{1}{R} \sum_{r=1}^{R} \frac{\lambda(\beta, v_1^r) \cdot \theta(\gamma, v_2^r)}{\theta(\gamma, v_2^r) - \lambda(\beta, v_1^r)} \cdot (exp(-\lambda(\beta, v_1^r) \cdot t) - \exp(-\theta(\gamma, v_2^r) \cdot t))$$

Table A 1: Maximum likelihood estimation with unobserved heterogeneity

Search Strategy	Non-sequential		Sequential	
Phase	Long	Short	Long	Short
Content	Screening	Application	Appl./Screen	Information
Registered vacancies in federal state (ln)	0.126	-0.315	0.047	2.023***
	(0.094)	(0.214)	(0.065)	(0.600)
Registered unemployed in federal state	-0.127	0.287	-0.064	-1.138***
	(0.078)	(0.179)	(0.068)	(0.385)
Firm size: 50–249	0.089	-0.117	0.118	0.240
	(0.072)	(0.181)	(0.100)	(0.418)
Firm size: 250+	0.249**	-0.411***	0.241*	2.710***
	(0.097)	(0.134)	(0.131)	(0.568)
Industry: Services	0.139	-0.202	0.025	-6.347***
	(0.119)	(0.277)	(0.091)	(0.660)
Industry: Temporary Employment Agen-	0.290*	1.271	0.339**	-5.912***
	(0.153)	(1.274)	(0.137)	(0.815)
Industry: Public Sector	0.178	-0.120	0.289**	-4.644***
	(0.160)	(0.367)	(0.122)	(0.529)
Industry: Others	-0.048	0.130	0.178	-5.498***
	(0.109)	(0.688)	(0.188)	(0.884)
Required skill level: Medium-skilled	-0.030	-1.630*	-0.424***	1.117
	(0.087)	(0.902)	(0.079)	(1.102)
Required skill level: High-skilled	0.011	-2.133**	-0.199	-4.011***
	(0.178)	(0.986)	(0.141)	(0.445)
Constant	1.936***	4.493***	2.115***	8.251***
	(0.143)	(0.714)	(0.249)	(1.594)
${\sigma_{v1}}^2$	0.005	[0.000;14.934]	0.086	[0.034;0.215]
${\sigma_{v1}}^2$	0.008	[0.001;0.070]	0.011	[0.001;0.119]
$\sigma_{v1,v2}$	-.004	[-.032;0.023]	-.027	[-.068;0.015]
Number of observations	3,285		997	
Log likelihood	2080.715		661.412	
Average estimated duration in days	44.952	17.778	55.147	1.324

Source: IAB Job Vacancy Survey, wave 2015. *Significance levels:* * 10 %, ** 5 %, *** 1 %. *Reference categories:* Firm size: 1–49, Industry: Manufacturing, Required skill level: Low-skilled. Standard errors are in parentheses and are adjusted for clustering at the federal state level. The reported estimates are derived from simulated maximum likelihood estimation using 100 draws.

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