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SEQUENTIAL OR NONSEQUENTIAL EMPLOYERS' SEARCH?

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ABSTRACT

This paper studies employers' search by analyzing the duration of vacancies notified at public employment offices. It appears that employers use a nonsequential search strategy to find new employees.

1. Introduction

Search in the labour market has been a popular field of theoretical as well as empirical analysis in the past decades. Durations of search have been analyzed using the concept of hazard rates. Whereas job search has been investigated intensively, employers' search has been analyzed in only a few studies (Devine and Kiefer, 1990). In a recent study Van Ours and Ridder (1992) suggest that the search strategy of employers differs from the search strategy of jobseekers. Jobseekers search sequentially, that is they receive job offers one by one and decide on arrival of a job offer whether or not to accept that offer. Employers search mostly nonsequential, that is they collect job applications to form a pool of applicants and they pick the best applicant from the pool.

This paper analyses vacancy duration data from public employment offices and presents a test to establish the search strategy of employers.

2. Employers' search

A vacancy hazard rate describes the rate by which vacancies are filled. Van Ours and Ridder (1992) study the search strategy of employers by analyzing the evolution of the vacancy hazard rate and the applicant arrival rate over the duration of the vacancy. Analyzing Dutch vacancy data, they find that the vacancy hazard rate is low in the first few weeks and increases afterwards to remain quite stable. The arrival rate of applicants is high in the first few weeks and is almost zero in the weeks thereafter. Apparently most applicants arrive in the period shortly after the vacancy has been announced, while few vacancies are filled during this period. From this they conclude that almost all vacancies are filled from a pool of applicants which is formed shortly after the posting of the vacancy. Therefore, vacancy durations should be interpreted mostly as selection periods and not as search periods for applicants. Van Ours and Ridder (1993) explicitly decompose a vacancy duration into an application period and a selection period, analyzing the determinants of both periods. In their theoretical model they assume that employers choose the length of the application period which maximizes the expected discounted profit flow from employing a new worker. They find that the size of the flow of applicants has a negative effect on the length of the application period. In their empirical analysis they find that the application period is rather short, which again confirms their conclusion that vacancy durations are mainly selection periods.

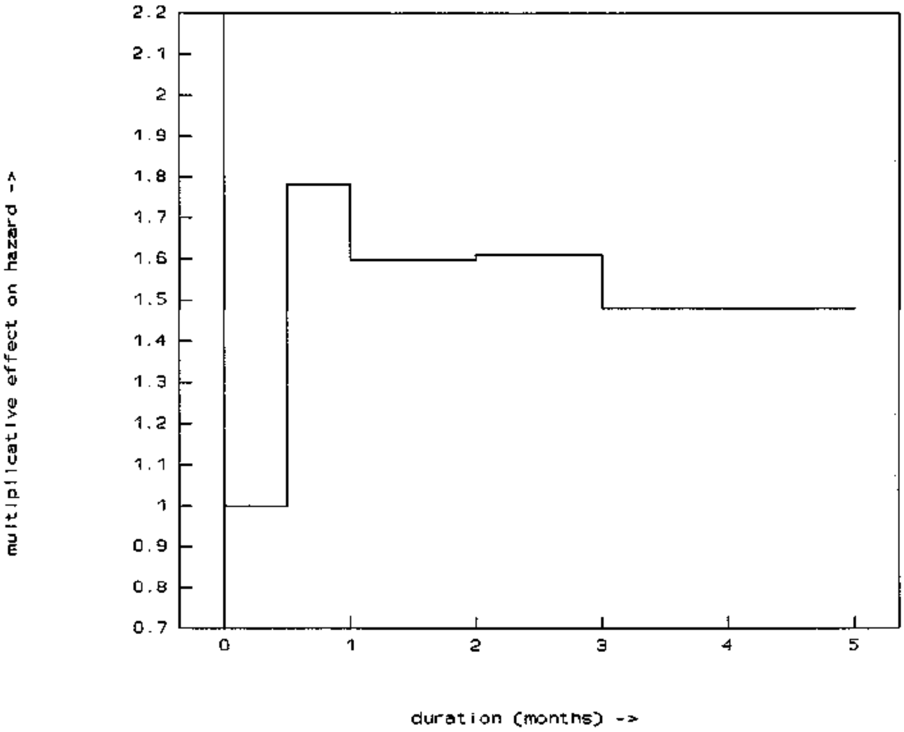

Figure 1 Duration dependence in notified vacancies data

In this paper we analyze durations of vacancies notified at public employment offices. A previous analysis of these data showed that here also the vacancy hazard rate is low in the first few weeks and higher afterwards (Van Ours, 1994). This duration dependence pattern is illustrated in figure 1, which is constructed from a reestimation of the model used by Van Ours.[1] Since the data do not contain information on numbers of applicants, the direct evidence of nonsequential employers' search is not very impressive. Furthermore, a stepwise increase of the vacancy hazard rate does not exclusively prove the existence of an application period followed by a selection period.

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[1]In this model the hazard rate is specified piecewise constant on specific intervals of duration, such that

$$\Theta(t) = \exp(X'\alpha + \Sigma_i I_i(t)\beta_i),$$

where $\Theta(t)$ is the hazard rate at duration t, X is a vector of explanatory variables (a constant included), α is a vector of coefficients, Σ_i is summation over the time intervals i (the reference interval excluded), $I_i(t)$ is a duration dependency dummy that equals 1 if t lies in interval i, and 0 otherwise, and β_i is the corresponding coefficient. Estimation results underlying figure 1 are presented in table 1.

A competing sequential search explanation of this phenomenon is that it takes some time before the employment office is able to match the information about the requirements of the vacant job and the information of relevant job seekers registered at the office. Once the information is matched the job seekers start visiting the sequential seeking employer, until the employer finds a suitable applicant in which case the vacancy is filled (assuming that the applicant accepts the job offer). This alternative explanation suggests that the length of the first period is determined by the *information matching* technology of the employment office, while the length of the second period is determined by the process of sequential search. The sequential search explanation also suggests that the applicant arrival rate is low in the first period and higher in the second period.

The competing explanation of sequential employers' search is invalidated in the study by Van Ours and Ridder (1992) because they find a high applicant arrival rate in the first period and low one in the second period.

The public employment office data we use do not allow a direct comparison of both competing explanations, but they do allow an indirect comparison by studying the effect of the local labour market situation on the hazard rates describing the length of both periods.

If the ratio of unemployed (U) to vacancies (V) is large, the applicant flow will be larger than with a small UV-ratio. Now, consider the effects of the UV-ratio in both cases. In the nonsequential case this ratio influences the inflow of job applicants in the first period: the higher the UV-ratio, the higher the applicant arrival rate and the shorter the application period. There is no influence on the second period, since the length of this period is determined by the selection technology of the employer.

The effects of the UV-ratio in case of sequential search is different. The length of the first period depends on the information matching technology of the public employment office, so we expect no influence of the UV-ratio in this period. In a constant returns to scale labour market a higher UV-ratio leads to a higher applicant arrival rate in the second period. The hazard rate of the second period is equal to the product of the applicant arrival rate and the acceptance probability of the employer. In many studies on job search the effect of a higher job offer arrival rate on the hazard rate is considered to be ambiguous, since a higher job offer arrival rate lowers the offer acceptance probability. However, as Van den Berg (1990) shows, a higher job offer arrival rate has an unambiguous positive effect on the hazard rate. Assuming that this regularity also applies for sequential employers' search, we expect a higher UV-ratio to have a positive effect on the hazard rate of the second period.

So, if we compare the effects of the UV-ratio on the hazard rate λ of the first period and the hazard rate θ of the second period, we are able to distinguish between sequential and nonsequential employers' search:

Sequential search:	$\lambda=\lambda(U/V, \cdot)$ 0	$\theta=\theta(U/V, \cdot)$ +
Nonsequential search:	$\lambda=\lambda(U/V, \cdot)$ +	$\theta=\theta(U/V, \cdot)$ 0

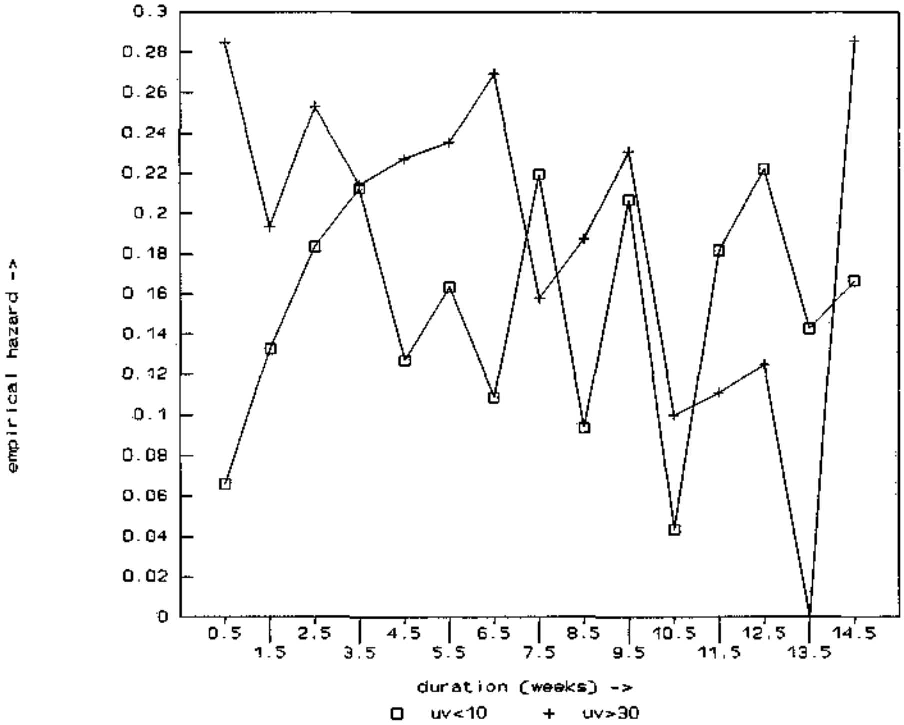

Figure 2 Empirical hazard rates for low and high UV vacancies (weekly intervals)

A first impression of the effect of the UV ratio on the hazard rates can be obtained by comparing empirical hazard rate patterns for low (U/V<10) and high (U/V>30) UV vacancies, which account for 24 and 26% of the total number of vacancies in our dataset, respectively. Figure 2 shows that the hazard rate is somewhat lower for low UV vacancies in the first few weeks after they are posted. Moving on in time, however, this image is troubled by increasing measurement errors in the empirical hazards. Thus, the most important observation that can be done is that it is practically impossible to disentangle the effects of the UV ratio by just doing some explorative statistics. The next sections discuss a more structural approach.

3. Empirical model

The modelling of sequential search is identical to that of nonsequential search. In either case, no vacancies are filled during the first period, due to information matching and the formation of a pool of applicants, respectively. Furthermore, in both cases vacancies are filled in the second period, due to the decisions of the sequentially seeking employer or the outcome of a selection process from the pool of applicants. So, while the modelling of both search strategies is the same, the interpretation of the parameters is fundamentally different.

In order to get an empirical specification of these search processes, we make the following assumptions (Van Ours and Ridder, 1993). In line with both interpretations of the model we assume that no vacancies are filled during the first period. Once the second period has started, the processes in the first period, information matching or pool formation, are stopped. The length of the first period is, conditional on a heterogeneity component, exponentially distributed with parameter λ. The same holds for the length of the second period with parameter θ. We will specify these parameters exponentially: $\lambda = e^{\beta' X + \mu}$ and $\theta = e^{\gamma' X + \nu}$. X is a vector of explanatory variables. β and γ are vectors of parameters. μ and ν are unmeasured heterogeneity terms that are assumed to be independently distributed with probability distributions g and h, respectively, such that

$$
\text{(1)} \qquad g(y) = \begin{cases} 1/(1+e^{\sigma}) & \text{if } y = \mu_1 \\ e^{\sigma}/(1+e^{\sigma}) & \text{if } y = \mu_2 \\ 0 & \text{otherwise,} \end{cases}
$$

and

$$
h(y) = \begin{cases} 1/(1+e^{\tau}) & \text{if } y = \nu_1 \\ e^{\tau}/(1+e^{\tau}) & \text{if } y = \nu_2 \\ 0 & \text{otherwise,} \end{cases}
$$

for some μ_1, μ_2, σ, ν_1, ν_2, and τ. Note that the expectation of the heterogeneity term does not necessarily equal zero, which makes a constant in X redundant.

Denote the length of the first period by A, and the length of the second period by B. Define the entire duration by T := A + B. The conditional distribution of A is given by $f_{A|\mu}(a) = \lambda e^{-\lambda a}$ if $a \geq 0$, and 0 otherwise. Furthermore, it holds that $f_{T|A,\nu}(t|a) = \theta e^{-\theta(t-a)}$ if $t \geq a$, and 0 otherwise. This implies that the simultaneous distribution of A and T is given by

$$(2) \qquad f_{A,T|\mu,\nu}(a,t) = f_{T|A,\nu}(t|a) f_{A|\mu}(a) = \lambda\theta e^{-\theta t} e^{-(\lambda-\theta)a},$$

if $t \geq a$, and 0 otherwise. Therefore, when $\lambda \neq \theta$, the marginal distribution of $T|\nu$ is given by

$$(3) \qquad f_{T|\mu,\nu}(t) = \int_0^t f_{A,T|\mu,\nu}(a,t)\,da = \frac{\lambda\theta}{\theta-\lambda}\left(e^{-\lambda t} - e^{-\theta t}\right),$$

if $t \geq 0$, and 0 otherwise. When $\lambda = \theta$, however, $T|\mu,\nu$ is gamma$(2,\lambda)$ = gamma$(2,\theta)$ distributed. The density of observed total durations, f_T, is obtained by mixing $f_{T|\mu,\nu}$ with respect to g and h, which gives $f_T(t) = \Sigma_{i,j=1,2} f_{T|\mu,\nu}(t|\mu_i,\nu_j) g(\mu_i) h(\nu_j)$.

Note that the marginal distribution in (3) is symmetrical in λ and θ, so there is no ex ante possibility to link λ to the first and θ to the second period. However, the pattern of duration dependency found by Van Ours (1992) shows that the first period, in which no vacancies are filled, is rather short. In the nonsequential case this is supported by the fact that the Dutch labour market was a buyer's market during the period of data collection, which shortens the application period. In the sequential case we expect a short period since information matching is not a very time consuming activity. Therefore, identification of $\lambda(\theta)$ as the parameter of the first (second) period can be achieved by restricting λ and θ to satisfy $\lambda > \theta$, i.e. in expectation A < B.

4. Data and variables

We use a sample from 5 local Dutch public employment offices of 501 vacancies, who were notified in the first quarter of 1988 and refer to single - one person wanted - vacancies. For each vacancy we know the duration as measured by the time between the date of notification and the date the vacancy was filled (Van Ours, 1994, provides more information on the data). The employment offices also register job seekers, most of which are unemployed. The unemployed workers are obliged to register at the public employment offices if they want to claim unemployment benefits. Unemployed may not all be equally motivated in accepting a job, if one is offered. Employers in the Netherlands frequently complain about the ability or motivation of the applicants send to them by the employment offices. Therefore in many cases employers use additional recruitment channels. So, the process by which notified vacancies are filled does not only reflect interactions between employment office and employer but also reflect the use of other recruitment channels.

The most important explanatory variable in our analysis is the UV-ratio, distinguished by occupation and region of the public employment office, which we specify as a natural logarithm. Of course, the UV-ratio is an explanatory variable for the hazard rates of both periods.

For the hazard rate of the first period we also use dummy variables for the employment offices. In the sequential search case these variables reflect differences in information matching technology between the offices. In the nonsequential case the dummy variables reflect local differences in employers' recruitment behaviour.

For the hazard rate of the second period we investigate several possible determinants, referring to characteristics of the vacancy or the employer who notified the vacancy. We use dummy variables for: metal or construction workers, service occupations at a secondary or higher educational level (reference group: other vacancies), size of the firm, distinguishing 10-50, 50-100 and >100 employees (reference group: 0-10 employees), temporary job, parttime job, intensive mediation.

The latter variable indicates which mediation method the employment office used to fill the vacancy. In case of intensive mediation vacancy information is matched with information about registered job seekers. Potentially suitable job seekers are notified about the vacancy. Sometimes, the office has an additional screening of the job seeker with respect to ability and motivation. In case of non-intensive mediation the employment office is rather passive. Information on job vacancies is stored in files, to which job seekers have access. Whether or not a job seeker applies is up to him or her. We expect intensive mediation to reduce the length of the second period. In both cases the quality of the applicants is improved, which may lead to a higher acceptance probability in case of sequential search or a shorter selection period in case of nonsequential search.

5. Estimation results

We define the likelihood as the probability of the 501 independent (complete) durations according to the model developed in section 3. Thus, the likelihood is given by $\Pi_i f_T(t_i)$, where t_i, i = 1..501, denote the observed durations. Maximizing this likelihood gives estimates of the relevant parameters.

The estimation results are shown in table 2. The left column contains the estimation results without unobserved heterogeneity, the right column those with two point unobserved heterogeneity. Using sample averages and the parameter estimates in the left column we find that λ represents an average duration of 0.5 weeks and θ an average duration of 3.5 weeks. Furthermore, in only 10 out of 501 cases λ was found to be smaller than θ. Thus, we conclude that λ is the parameter of the first and θ the parameter of the second period. We find no unobserved heterogeneity in the first period and a heterogeneity term in the second period which is only significant on a 10% level. Also, from a comparison of the loglikelihoods it appears that the introduction of unobserved heterogeneity does not improve our estimation results significantly (likelihood ratio statistic: 2.0). Furthermore, note that the model performs better than the flexible duration dependency model presented in table 1 (it has a higher likelihood together with less degrees of freedom). Our discussion of the estimation results is therefore restricted to the left column of table 2.

It appears that the UV-ratio has a positive effect on the hazard rate of the first period, while having no effect on the hazard rate of the second period. From this we conclude that employers' search is nonsequential. In those cases where λ was smaller than θ, the UV ratio was small, i.e. less than 3 (the sample average of the UV ratio is 23.4). Obviously, this concerns vacancies that were hard to fill because of a lack of potential applicants. Apart from differences in the UV-ratio the hazard rate of the application period is also different for different employment offices, probably reflecting differences in recruitment behaviour between employers in different regions. The only significant variable for the hazard rate of the selection period is the dummy for temporary job: the selection period for vacancies for temporary jobs is shorter than average, which seems quite obvious since the consequences of attracting a non suitable applicant are less serious for a temporary job than in case of a steady job. Workers on temporary jobs do not have to be fired and therefore do not involve firing costs. Intensive mediation has a positive but not significant effect on the hazard rate of the selection period.

6. Conclusions

This paper presents an analysis of vacancy duration data, using a simple test to distinguish between sequential and nonsequential employers' search. From this test it appears that employers search nonsequentially. They announce a vacancy, form a pool of applicants, start a selection process and pick the new employee from the pool.

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Table 1. Estimation results model with flexible duration dependence

ln(U/V)	0.17 (2.4) **
employment office 1	0.38 (2.3) **
employment office 2	0.45 (2.2) **
employment office 3	0.28 (1.5)
employment office 4	0.42 (2.1) **
metal and construction	-0.15 (1.4)
services (sec. and higher)	-0.22 (2.3) **
10-50 employees	-0.05 (0.5)
50-100 employees	-0.21 (2.0) **
> 100 employees	-0.12 (1.1)
temporary job	0.28 (4.0) **
parttime job	-0.15 (1.8) *
intensive mediation	0.22 (2.7) **
2-4 weeks	0.58 (6.0) **
1-2 months	0.47 (4.4) **
2-3 months	0.48 (3.2) **
> 3 months	0.39 (2.1) **
constant	-2.75 (10.5) **
loglikelihood	-533.8

*Explanatory note: absolute t-values in parentheses; ** (*) denotes significance on a 5% (10%) level.*

Table 2. Estimation results two period model

	without heterogeneity	with heterogeneity
λ (first period)		
ln(U/V)	0.60 (2.3) **	0.50 (1.8) *
employment office 1	0.49 (0.9)	0.42 (0.9)
employment office 2	0.23 (0.2)	0.23 (0.3)
employment office 3	1.08 (1.4)	0.90 (1.3)
employment office 4	3.43 (2.2) **	3.57 (2.5) **
μ_1	-1.96 (3.3) **	-2.01 (2.4) **
μ_T-μ_1		0.00 (0.0)
σ		0.10 (0.0)
θ (second period)		
ln(U/V)	0.06 (0.4)	0.04 (0.3)
metal and construction	-0.18 (0.8)	-0.18 (0.7)
services (sec. and higher)	-0.22 (1.2)	-0.28 (1.3)
10-50 employees	-0.06 (0.4)	-0.05 (0.3)
50-100 employees	-0.29 (1.2)	-0.25 (0.9)
> 100 employees	-0.11 (0.5)	-0.14 (0.6)
temporary job	0.37 (2.4) **	0.44 (2.0) **
parttime job	-0.19 (1.1)	-0.21 (1.0)
intensive mediation	0.19 (1.1)	0.18 (0.8)
ν_1	-1.53 (3.2) **	-0.86 (1.0)
ν_T-ν_1		-0.91 (1.9) *
τ		-0.03 (0.0)
loglikelihood	-528.0	-527.0

Note: in the second estimation σ *was not identified ex post, because* μ_T-μ_1 *did not differ from 0 significantly.*