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JOB VACANCIES AND EMPLOYERS' SEARCH'

An empirical analysis of Dutch job vacancy data

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JOB VACANCIES AND EMPLOYERS' SEARCH^{*)}

An empirical analysis of Dutch job vacancy data

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ABSTRACT

This paper contains an extended analysis of Dutch job vacancy data. It presents the estimation results of both reduced form and structural models of employers' search. In the reduced form model information is used about vacancy durations, in the structural model information on both vacancy durations and applicants arriving is used.

In the first type of structural model the so called hazard rate which governs the flow of filled job vacancies is split up in the applicant arrival rate and the applicant acceptance probability. In this model the employer has to decide instantaneously on arrival of the applicant whether or not the applicant is acceptable. It appears that most applicants arrive within the first few weeks of the existence of the vacancy. Furthermore the applicant arrival rate is influenced by many variables, while the duration of the job vacancy is influenced only by required skills: education, working experience and occupation. The reason for this is probably that employers search by collecting applications, creating a pool of applicants and picking out an acceptable applicant from that pool. Employers, rather than using a large applicant arrival rate to fill their vacancy quickly, use it to form a larger pool of applicants to select their new employee from.

In the second type of structural model the hazard rate is specified in order to allow for employers selecting suitable applicants from a pool of applicants. From the estimation results it appears that vacancy durations are to a large extent determined by time consuming selection procedures. The numbers of applicants arriving have only a limited effect on vacancy duration.

JOB VACANCIES AND EMPLOYERS' SEARCH

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1. Introduction

In the past there have been and at the moment there still are numerous empirical studies on unemployment durations. These studies use results of the so called job search theory, either to formulate structural models of durations of unemployment spells or to interpret results of reduced form models. (Mortensen, 1986). The latter are often specified as hazard models (Kiefer, 1988).

Job search theory is usually about the strategy of an unemployed job seeker, who accepts a job offer with a wage that exceeds his reservation wage and turns down all other offers. The probability of a job seeker finding a job is the product of the probability of that job seeker obtaining a job offer and the probability the job seeker accepts that job offer. Empirical studies come to different conclusions but many authors conclude that the acceptance probability is almost equal to 1, so job seekers accept the first job offer they get.

If this is true then durations of unemployment spells are determined by the probability of obtaining a job offer in some time interval. Such a characteristic of the labour market is not unrealistic in periods of mass unemployment. Vacancies may be so scarce that they will be immediately accepted when located. If this is the characteristic of today's labour market then the interest shifts from the acceptance strategy of the job seeker to the search and hiring strategy of the employer which determines how long it takes to make an offer to a job seeker and who receives the offer.

Empirical studies on employers' search are scarce possibly due to a lack of adequate data. There are studies on employers' search by Barron and Bishop (1985) and Barron, Bishop and Dunkelberg (1985, 1987). Studies using micro job vacancy data are by Beaumont (1978) and Roper (1988). Beaumont analyzed the durations of job vacancies using data on the outflow of vacancies registered by public employment offices. Roper used data from an employers' survey in which employers were asked about details of their most recent and in some cases their two most recent hires. Dutch studies using aggregate job vacancy

data to estimate vacancy durations are by Van Ours and Ridder (1989).

Studies using micro job vacancy data estimating a structural and a reduced form model of employers search are by Van Ours (1989a and 1989b). In the structural model information was used about both job vacancy duration and number of applicants arriving; the reduced form model only used information on vacancy durations. This paper contains an extended analysis of the job vacancy data used in these studies (See Renes (1989) for another analysis based on data from the same vacancy survey). The paper is set up as follows. Section 2 presents the data used in the analysis. Furthermore in this section the variables influencing employers' search behaviour are briefly discussed. In section 3 there is a sketch of a possible theory of employers' search developed along parallel lines to job search theory. Section 3 also contains the results of an empirical analysis based on a reduced form model of employers' search. Section 4 presents the estimation results of a structural model of employers search. Section 5 contains the results of a simple structural model allowing for time consuming selection procedures. The conclusions are summarized in section 6. About some aspects of employers search and job vacancies the discussion is brief. We refer to Van Ours (1989a and 1989b) for more extended discussion on for example the concept of a job vacancy and the data used in the analysis.

2. The data and explanatory variables used in the analysis

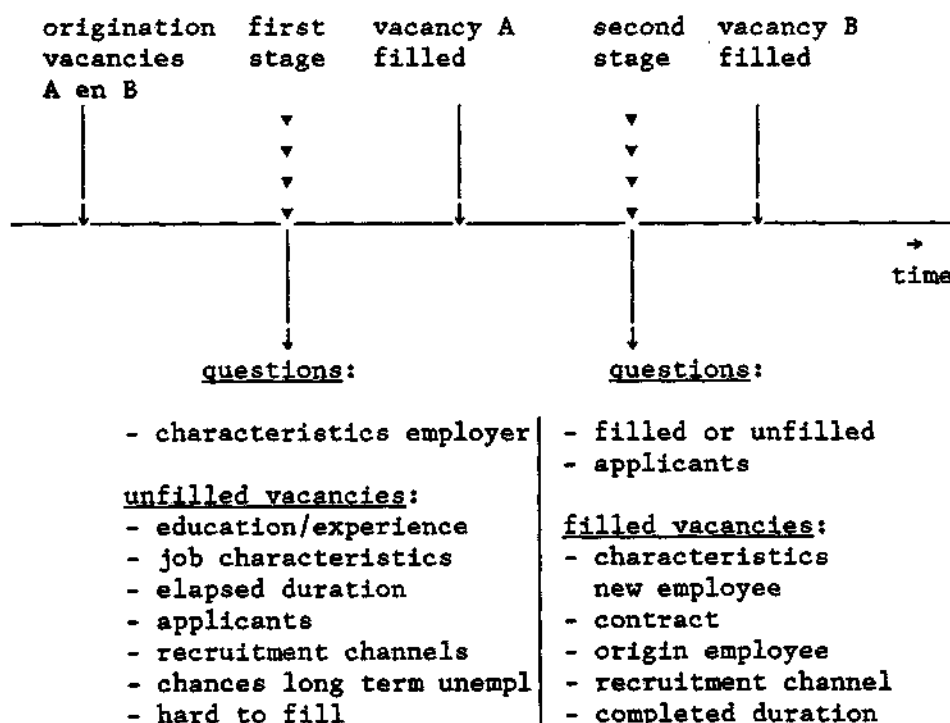
2.1 The data

The data used in the analysis are from a job vacancy-survey of the Organisatie voor Strategisch Arbeidsmarkt-onderzoek (OSA). Employers who had no vacancies or only a few vacancies were interviewed by telephone, otherwise they were first contacted by telephone and then visited by field investigators. The sample of 1913 employers with more than 10 employees was drawn from the database of the Dutch Chambers of Commerce, in which government and education as well as private employment agencies are excluded.

The introductory question in the survey was: Do you have at this moment job vacancies for which you are searching employees whom you want to put to work immediately or as soon as possible?

The job vacancy survey was held in two stages. During the first stage in the months November 1986 - January 1987 employers were asked if they had vacancies and if so they were questioned about the skills they required for their job vacancies, the kind of jobs the vacancies referred to, their recruitment methods and selection procedures, the number of applicants, the (incomplete) duration of the job vacancies, the characteristics of the hard-to-fill job vacancies and the chances long-term unemployed would have if they applied (See figure 1).

Figure 1 The OSA Job vacancy survey



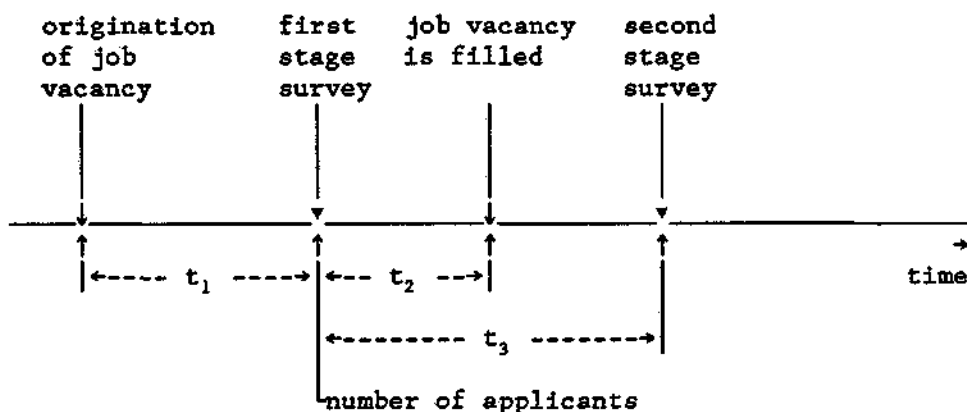
The second stage of the survey was held some four months later and was restricted to employers who had vacancies at the first stage of the survey. Employers were asked if the job vacancies of the first stage had been filled and if so they

were questioned about the skills of the new employee, the labour market position he or she came from, the completed duration of the job vacancy, the number of applicants and so on.

Information concerning the number of applicants contained errors. In many cases the number of applicants reported in the second stage of the survey was smaller than the number of applicants reported in the first stage. It appears that the probability that this occurs increases with the duration of the job vacancy and the time elapsed between the moment the vacancy was filled and the second survey. We think that mistakes made in reporting the number of applicants are due to a memory-effect. We therefore only use information about applicants from the first stage of the survey where this memory-effect has the smallest impact.

The information on job vacancy duration and applicants used in the analysis are shown in figure 2.

Figure 2 Information on vacancy duration and applicants used in the analysis



- t_1 = the elapsed duration of the job vacancy at the first stage of the survey
- t_2 = the time between the first stage and the job vacancy being filled
- t_3 = time between the two stages of the survey

Of some of the filled job vacancies who have no precise duration information. We just know that they were filled between the two stages of the survey. Therefore with relation

to duration information we have three type of job vacancies:

Type 1: filled, completed duration t_1+t_2

Type 2: filled, $t_1 < \text{completed duration} < t_1+t_3$

Type 3: unfilled, completed duration $> t_1+t_3$

After discarding information on multiple vacancies and vacancies for which essential variables are missing a sample of 670 job vacancies remains, of which there are 446 type 1, 50 type 2 and 174 type 3.

2.2 The explanatory variables

In the analysis we distinguish 5 groups of explanatory variables:

a. Required skills: Job vacancies differ in required skills such as level of education, minimum working experience and type of occupation. The effect these variables have on vacancy duration may reflect on the one hand labour market conditions, for example the relative abundance of low skilled unemployed. On the other hand differences in required skills may also influence acceptance behaviour of the employer, which is probably more selective the higher the required skills. To allow for differences between types of occupation we distinguished clerical/business vacancies from industrial and other vacancies.

b. Recruitment practices: Employers' search behaviour differs in several ways. First of all some vacancies refer to vacant positions, while others refer to still occupied jobs. For the latter employers may be more selective than for the former. Employers also have different methods to recruit for a job vacancy. They can advertize, report the job vacancy to the public employment office, use informal recruitment channels as well as recruit within their firms, recruit through private employment agencies or schools. Employers are not restricted to one recruitment channel. In the analysis we distinguished whether or not an employer used an advertisement or reported the vacancy to the public employment office. Finally we distinguished between vacancies for which a testing-procedure was used and vacancies for which this was not the case.

c. Job characteristics: There are several job characteristics

which make jobs more or less attractive to potential applicants. For example vacancies which refer to jobs with a permanent labour contract, jobs without unpleasant working conditions (dust, bad smells, high temperatures) and full-time jobs may attract more applicants, thus shortening vacancy-durations.

d. Employer characteristics: Larger employers may search more intensive for new employees than medium-sized employers. According to Barron, Bishop and Dunkelberg (1985) larger employers interview more applicants per employment offer. Probably also the presence of a separate personnel department within the firm will lead to a more intensive selection procedure. Large firms may also be less attractive for potential applicants than medium sized firms.

e. Labour market conditions When regional unemployment is high there is a large potential reservoir of applicants. We therefore expect the flow of unemployed applicants to increase with regional unemployment. On the other hand job mobility decreases with unemployment so the flow of employed applicants may be smaller when regional unemployment is high (Parsons, 1976).

A table with the definitions of the explanatory variables is given in Appendix 1, while Appendix 2 shows the means of all explanatory variables.

3. An elementary employers' search model

An elementary employers' search model starts with the assumption that there is a vacant position for which potential employees apply. Furthermore we are assuming that wages are given, the employer knows the distribution of the productivity of possible new employees and the employer is able to assess the productivity of an applicant. Employers' search is not costless, there are for example screening and advertising costs. An applicant is accepted if the return to employing that applicant exceeds the return to further search. This decision rule is in fact a reservation strategy. An applicant qualifies if his productivity exceeds an acceptance level: the

reservation productivity of the employer. Finally we assume that the employer decides whether or not an applicant is acceptable on the moment of arrival of that applicant and we assume there is no recall.

Consider a job vacancy indexed by i , during an infinitesimal short period $(t, t+dt)$. The arrival rate of applicants during this period is $m_i(t)dt$. The probability $P_i(t)$ that an applicant is acceptable after t periods, is given by the probability of his or her productivity is equal to or greater than the reservation productivity $x_i^*(t)$ the employer has after t periods:

$$P_i(t) = \int_{x_i^*(t)}^{\infty} f_i(x) dx \quad [1]$$

The transition or hazard rate that governs the flow of filled job vacancies, is the product of the applicant arrival rate and the probability an applicant is acceptable (dropping the index i):

$$\theta(t) = m(t) \cdot P(t) \quad [2]$$

In this section we use information on completed and elapsed durations of job vacancies to estimate $\theta(t)$. In the next section we combine information on vacancy-durations and flows of applicants to estimate $P(t)$ as a resultant of $\theta(t)$ and $m(t)$.

The relation between the hazard rate $\theta(t)$ and the probability density function of completed job vacancies $g(t)$ is:

$$g(t) = \theta(t) \cdot e^{-\int_0^t \theta(s) ds} \quad [3]$$

We estimate a simple hazard function, the hazard rate being a function of explanatory variables only:

$$\theta(t) = \theta = \exp(X'\beta) \quad [4]$$

From other analyses (Van Ours, 1989a) we know there is some positive duration dependence and some unobserved heterogeneity. Our interest for the moment lies in the influence of the explanatory variables on the hazard rate.

In the estimation we used information on residual durations after the first stage of the survey, with the conditional probability density function:

$$f(t_2 | t_1) = g(t_1 + t_2) / [1 - G(t_1)] \quad [5]$$

in which $G(t)$ is the distribution function of the vacancy durations.

The appropriate likelihood for our sample is:

$$L_1 = \frac{f_c}{\prod_{j=1}^{f_c} [1 - G(t_1)]} \cdot \frac{f_i}{\prod_{k=1}^{f_i} [1 - G(t_1)]} \cdot \frac{u}{\prod_{l=1}^u [1 - G(t_1)]} \quad [6]$$

where: f_c = number of filled job vacancies in the sample with complete information

f_i = number of filled job vacancies in the sample with incomplete information

u = number of unfilled job vacancies in the sample

The estimation results are shown in table 1. From table 1 it appears that there are only a few variables with a significant influence on job vacancy duration.

Table 1 Estimation results reduced form model

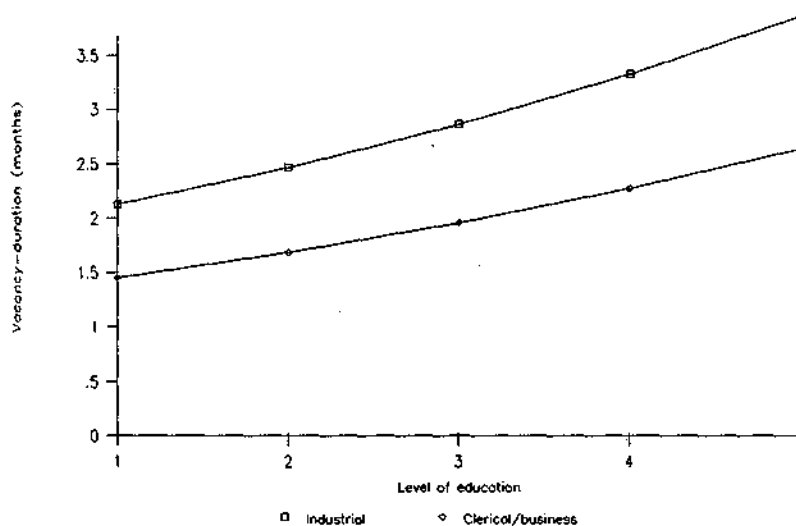
	coeff. of θ
1. Constant	-2.66 (6.5)**
2. Clerical/business occup	0.38 (3.3)**
3. Industrial occupation	-0.15 (1.0)
4. Education required	-0.15 (2.2)**
5. Working experience req.	-0.10 (2.7)**
6. Occupied position	0.12 (1.3)
7. Advertisement	0.16 (1.7)*
8. Employment office	-0.00 (0.0)
9. Testing-procedure	-0.19 (1.7)*
10. Permanent contract	0.09 (0.9)
11. Labour conditions	0.18 (1.6)
12. Part-time job	0.06 (0.3)
13. Number of employees	-0.08 (1.2)
14. Personnel department	0.04 (0.4)
15. Regional unemployment	0.02 (0.8)
-loglikelihood	1654.8

*: significant at 10%-level; **: significant at 5%-level

Job vacancies for clerical/business occupations last shorter than other vacancies. We think labour market conditions are responsible for this. Vacancies requiring higher education or more working experience last longer than other vacancies. This is probably due to a more restrictive selection with higher required skills. At the 10%-level there is a significant influence of advertisement and testing-procedure. Vacancies with advertisement last shorter than vacancies without, while the application of a selection-procedure leads to a longer vacancy duration. To give an impression of the magnitude of the influence of required skills on average vacancy durations figure 3 shows some calculated durations.

Figure 3 Average vacancy-durations and required skills

a. level of education



b. minimum working experience

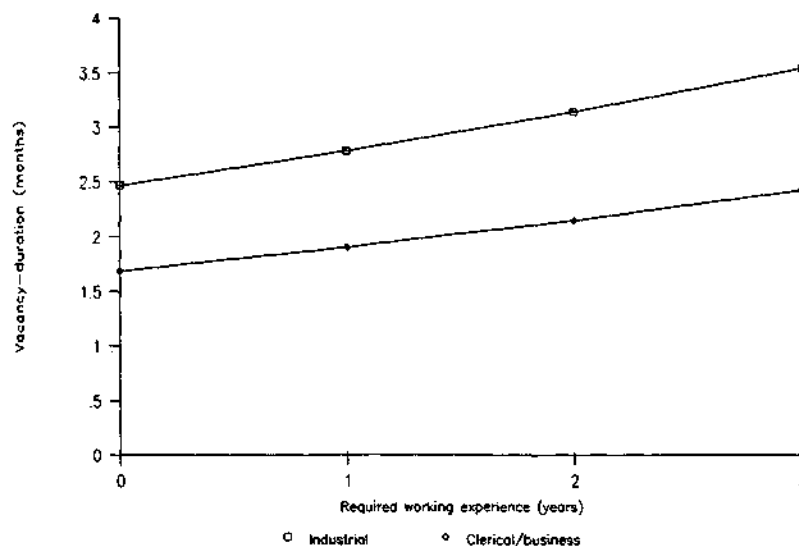


Figure 3 shows that for unskilled clerical/business vacancies average job vacancy duration is about 1.5 months, increasing to 2.5 months for that type of vacancies on academic level. For industrial vacancies average duration ranges from 2 till 4 months. If no working experience is required clerical/business vacancies last 1.7 months on average, which is 2.2 months for that type of vacancies requiring at least 3 years of working experience. For industrial vacancies the average duration varies from 2.5 months at an unexperienced level to 3.5 months at a very experienced level.

4. A structural model of employers' search

For the estimation of the structural search model we assume a Poisson arrival of applicants and use as stated before information from the first stage of the survey. The conditional probability density function for the number of applicants becomes:

$$f_2(k|t_1) = \frac{\left(\int_0^{t_1} m(s) ds \right)^k}{k!} \cdot e^{-\int_0^{t_1} m(s) ds} \quad [7]$$

where: k = the number of applicants

In estimating we again use information on residual durations after the first stage of the survey, with the conditional probability density function:

$$f_3(t_2|t_1) = \frac{m(t_1+t_2) \cdot P(t_1+t_2) \cdot e^{-\int_0^{t_1+t_2} m(s) \cdot P(s) ds}}{e^{-\int_0^{t_1} m(s) \cdot P(s) ds}} \quad [8]$$

As shown in table 2 we use two specifications for the applicant arrival rate m and the acceptance probability P. In the first specification both m and P are constant over time and a

function of explanatory variables. In the second specification there is duration dependence by means of interval dummies: within an interval both m and P are constant, between intervals they may differ.

Table 2 Specifications of m and P

a	$m = \exp(X'\mu + \phi^*)$	$P_1 = \exp(X'\beta + \delta^*)/[1 + \exp(X'\beta + \delta^*)]$
b	$m = \exp(X'\mu + \phi_j)$	$P_2 = \exp(X'\beta + \delta_j)/[1 + \exp(X'\beta + \delta_j)]$

a) X : set of explanatory variables
 μ, β : coefficients to be estimated
 ϕ, δ : interval dummies; j =interval: 0-1 month, 1-2 month, ... 6+ months; ϕ^*, δ^* : constants

The joint probability density function of t_2 and k , conditional on t_1 is:

$$h(t_2, k|t_1) = f_2(k|t_1) \cdot f_3(t_2|t_1) \quad [9]$$

The appropriate likelihood for our sample is:

$$L = \prod_{k=1}^{f_0} h(t_1, t_2, k) \cdot \prod_{l=1}^{f_1} \int_0^{t_3} h(t_1, t_2, k) dt_2 \cdot \prod_{n=1}^u \int_{t_3}^{\infty} h(t_1, t_2, k) dt_2 \quad [10]$$

The estimation results are shown in table 3. It is obvious that the interval dummies differ significantly. For m the dummy of the first interval (less than 1 month) is much larger than the dummies of the other intervals. For P it is the other way round: the dummy for the first interval is much smaller than the others. Apparently m has a strong negative duration dependence, while P has a positive duration dependence. The loglikelihood of the second estimation is significantly higher than the loglikelihood of the first. Therefore we will discuss the coefficients of the explanatory variables in the second estimation.

The coefficients of the explanatory variables of the applicant arrival rate are often significant. For example: advertising for vacancies attracts more applicants than the other recruitment methods, large firms attract less applicants.

Vacancies for clerical/business and industrial occupations attract more applicants than other vacancies. Unemployment does not influence the applicant arrival rate. This may be due to compensating effects of the flow of unemployed and employed applicants: the former increases with unemployment, the latter decreases with unemployment.

Table 3 Estimation results structural model

	coeff.m	coeff. P	coeff. m	coeff. P
1. Constant	-1.45 (12.7)**	-1.02(2.2)**		
dummy 0-1 month			-0.87 (9.6)**	-1.34 (1.7)
1-2 month			-4.03 (22.7)**	3.24 (3.6)**
2-3 month			-4.04 (21.9)**	4.12 (4.4)**
3-4 month			-4.10 (18.0)**	3.61 (3.2)**
4-5 month			-3.78 (15.9)**	3.40 (3.1)**
5-6 month			-4.08 (13.1)**	3.64 (3.1)**
6+ month			-4.13 (14.7)**	3.09 (3.0)**
2. Clerical/business occup	0.65 (20.9)**	-0.28 (2.2)**	0.51 (16.4)**	-0.24 (0.9)
3. Industrial occupation	0.17 (4.0)**	-0.33 (1.9)*	0.24 (5.8)**	-0.41 (1.1)
4. Education required	-0.03 (1.7)*	-0.12 (1.5)	0.14 (7.3)**	-0.41 (2.2)**
5. Working experience req.	-0.01 (0.7)	-0.11 (2.2)**	-0.01 (1.4)	-0.01 (1.4)
6. Occupied job	0.27 (10.5)**	-0.16 (1.4)	0.17 (6.4)**	-0.03 (0.1)
7. Advertisement	1.19 (34.6)**	-1.13 (10.1)**	1.17 (35.6)**	-1.93 (6.1)**
8. Employment office	-0.09 (3.1)**	0.09 (0.8)	0.06 (2.1)**	0.12 (0.5)
9. Testing procedure	-0.12 (3.9)**	-0.08 (0.6)	-0.03 (1.0)	-0.31 (1.2)
10. Permanent contract	-0.18 (6.2)**	0.29 (2.6)**	-0.11 (3.8)**	0.28 (1.1)
11. Labour conditions	0.23 (7.6)**	-0.05 (0.4)	0.20 (6.8)**	-0.17 (0.6)
12. Part-time job	-0.09 (1.8)*	0.18 (0.9)	0.21 (4.3)*	0.20 (0.5)
13. Number of employees	-0.20 (9.3)**	0.12 (1.5)	-0.19 (9.0)**	0.01 (0.7)
14. Personnel department	0.45 (14.9)**	-0.45 (3.7)**	0.32 (11.1)**	-0.57 (2.1)**
15. Regional unemployment	0.02 (2.6)**	0.00 (0.1)	0.01 (0.4)	0.04 (1.3)
-loglikelihood	8544.5		6971.5	

*: significant at 10%-level

**: significant at 5%-level

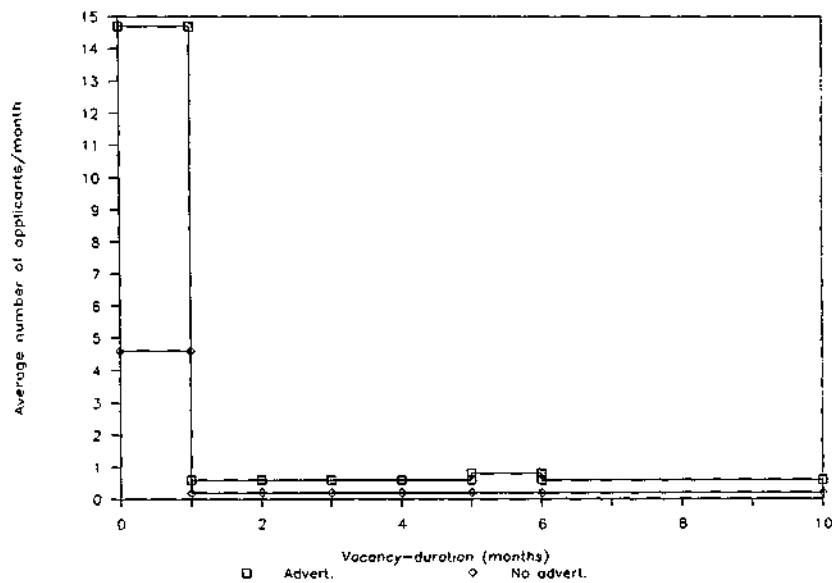
What we cannot explain is why vacancies for occupied jobs and jobs with unpleasant working conditions attract more applicants than on average while jobs which offer a permanent contract attract less applicants. The applicant acceptance probability is influenced by just three variables. For vacancies requiring higher education, vacancies for which an advertisement was

placed and vacancies with firms which have a separate personnel department the applicant acceptance probability is significantly smaller.

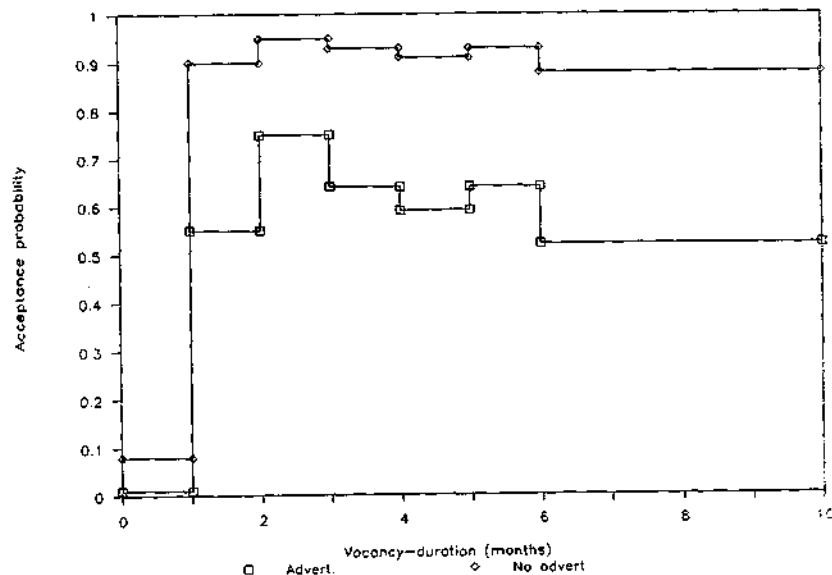
To illustrate the magnitude of some of the results figure 4 shows the applicant arrival rates for two types of clerical/business vacancies at extended primary educational level: one with and the other without an advertisement being placed.

Figure 4 Applicant arrival rates and applicant acceptance probabilities over the duration for clerical/business vacancies at extended primary educational level, with and without an advertisement being placed

a. average number of applicants per month



b. average applicant acceptance probability



As shown in figure 4 placing an advertisement influences the applicant arrival rate substantially. In the first month of the existence of the vacancy about 15 applicants arrive on average if an advertisement is placed. Without an ad that is 4.5 applicants in the first month. After that the arrival rate reduces to practically zero. The applicant acceptance probability also depends on the placement of an advertisement. During the first month both are very small. Afterwards for the vacancy with an ad the acceptance probability is fluctuating at a level of about 0.6, for the vacancy without an ad this is about 0.9.

If we combine the information derivable from the estimation results in this and the previous section we have two major findings:

1. The applicant arrival rate is very time dependent. Most applicants arrive within the first few weeks of the existence of the vacancy. Afterwards only a few applicants arrive.
2. The applicant arrival rate is influenced by many variables, while the duration of the job vacancy is influenced only by required skills: education, working experience and occupation.

To our opinion two conclusions may be drawn on these findings. The first is that the size of the flow of applicants towards a vacant position is not very important with respect to the duration of the vacancy. The second is that the reason for this is probably that employers search by collecting applications, creating a pool of applicants and picking out an acceptable applicant from that pool. The latter conclusion means that employers, rather than using a large applicant arrival rate to fill their vacancy quickly, use it to form a larger pool of applicants to select their new employee from.

5. Simple models with selection procedures

5.1 Numbers of applicants

There are two major differences between the employers' search as modelled in section 4 and employers searching by selecting from a pool of applicants. The first difference is

that the employer cannot decide immediately on arrival of the applicant whether or not an applicant is acceptable: selection procedures are time consuming. The second difference is that the applicant arrival rate does not seem to determine the vacancy duration directly. A higher arrival rate does not shorten the duration of the vacancy but gives a larger pool of applicants.

A further analysis of the process of applicants arriving showed that the number of applicant stabilised after a period of about 2 weeks. We estimated the size of the pool of applicants using information about applicants from the first stage of the survey. We estimated:

$$f_2(k|t_1) = \frac{(m \cdot t_1)^k}{k!} \cdot e^{-m \cdot t_1} \quad \text{for } t_1 < 2 \text{ weeks}$$

$$= \frac{(2 \cdot m)^k}{k!} \cdot e^{-2 \cdot m} \quad \text{for } t_1 > 2 \text{ weeks} \quad [11]$$

in which m is an exponential function of explanatory variables only. The estimation results of m are shown in table 4.

Table 4 Estimation results expected number of applicants

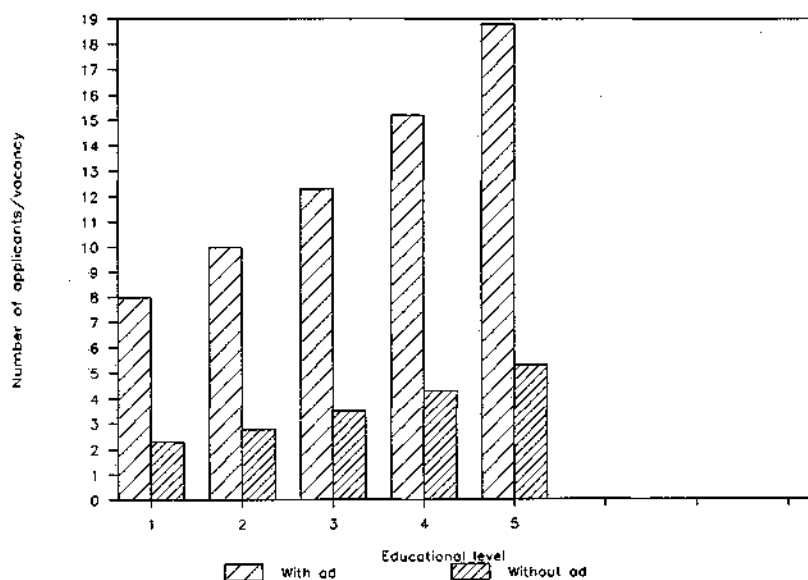
	Coeff. of m
1. Constant	-0.51 (5.5)**
2. Clerical/business occup	0.47 (14.9)**
3. Industrial occupation	0.26 (6.4)**
4. Education required	0.21 (10.8)**
5. Working experience req.	-0.06 (0.6)
6. Occupied position	0.15 (5.7)**
7. Advertisement	1.27 (27.2)**
8. Employment office	0.08 (2.8)**
9. Testing-procedure	-0.02 (0.7)
10. Permanent contract	-0.11 (3.9)**
11. Labour conditions	0.21 (7.1)**
12. Part-time job	0.21 (4.3)**
13. Number of employees	-0.18 (8.4)**
14. Personnel department	0.26 (8.6)**
15. Regional unemployment	0.01 (2.1)**
-loglikelihood	4902.1

*: significant at 10%-level; **: significant at 5%-level

To illustrate the magnitude of the results figure 5 shows for clerical/business vacancies the relation between average number of applicants per vacancy and required educational level and size of the firm.

Figure 5 Total numbers of applicants for clerical/business vacancies with and without an advertisement being placed; by educational level and size of firm

a. number of applicants and educational level



b. number of applicants and size of firm

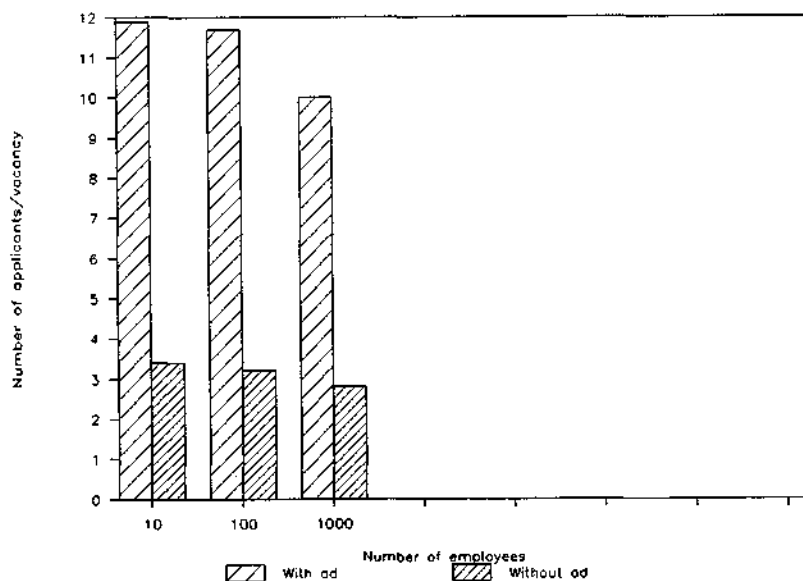


Figure 5 shows again that an advertisement attracts a substantial number of applicants. Without an ad the number of applicants per vacancy increases from 2 at the lowest educational level to 5 at the highest. The size of the firm has

a negative influence on the number of applicants. With an ad a firm of 10 employees attracts about 12 applicants per vacancy, without an ad that is about 10.

5.2 Vacancy duration and number of applicants

If the applicant arrival rate is not important with respect to vacancy durations probably the total number of arriving applicants is. Whether or not this is so also depends on whether or not there is an acceptable applicant in the pool. Of course there is a relation between the size of the pool of applicants and the probability an applicant in the pool is acceptable:

$$P_{pi}(t) = [1 - (1 - P_i(t))^{k_i}] \quad [12]$$

in which $P_i(t)$ is the probability that a random applicant is acceptable for the employer. P_i may be duration dependent because employers may change their reservation productivity over time.

The hazard rate may depend on the total number of applicants arriving at the start of the vacancy, the probability that at least one of the applicants is acceptable for the employer and the rate at which applicants are selected from the pool of applicants:

$$\theta_i(t)dt = N_i^\sigma \cdot P_{pi}(t) \cdot s_i(t) dt \quad [13]$$

in which: N = the expected number of applicants
 σ = returns to scale
 P_p = probability an applicant in the pool is acceptable
 s = selection rate

In [13] the returns to scale are expected to be smaller than 1 because of decreasing returns to scale: $0 < \sigma < 1$. If $\sigma=0$ then there would be no returns to scale: the number of applicants is irrelevant with respect to the hazard rate. $s_i(t)$ is the rate at which a suitable applicant is accepted from the pool of applicants. We may use information on vacancy durations to estimate $\theta(t)$ and information on applicants in the first stage of the survey to estimate σ . We can however not distinguish

between $P_p(t)$ and $s(t)$. Therefore we assume $P_p(t) = 1$: We assume that in every pool of applicants there is at least 1 applicant suitable for the job. If we furthermore assume that $s(t)$ is only a function of explanatory variables and not time dependent [13] becomes (omitting the index i):

$$\theta = N^\sigma \cdot \exp(X'\mu) = \exp(X'\mu + \sigma \cdot \log(N)) \quad [14]$$

We estimated [14] using the likelihood functions specified in [6]. N was calculated as the expected number of applicants m , the parameter of a Poisson arrival function, of which the estimation results are shown in table 4.

Table 5 Estimation results structural model

	θ_1	$m^\sigma \cdot s$	θ_2
1. Constant	-2.34 (13.9)**	-2.58(10.0)**	-2.49 (12.9)**
2. Clerical/business occup	0.43 (4.8)**	-0.34 (2.8)**	0.41 (4.5)**
4. Education required	-0.13 (2.3)**	-0.17 (2.6)**	-0.14 (2.4)**
5. Working experience req.	-0.09 (2.3)**	-0.09 (2.3)**	-0.08 (2.2)**
7. Advertisement	0.13 (1.4)	0.21 (0.7)	0.04 (0.4)
9. Testing procedure	-0.22 (1.9)*	-0.21 (1.8)*	-0.21 (1.9)*
τ		0.28 (1.2)	
Dummy no appl, < 2weeks			0.20 (0.9)
Dummy 1-5 applicants			0.17 (1.2)
Dummy > 5 applicants			0.37 (2.7)**
-loglikelihood	1659.0	1658.2	1654.9

*: significant at 10%-level

**: significant at 5%-level

The estimation results of [14] shown in table 5 indicate however that σ does not differ significantly from zero, which would imply that the total number of applicants arriving is irrelevant with respect to the duration of the job vacancy. There are two possible explanations for this. One is that P_p , the probability that there is an acceptable applicant in the pool, is more important than we think. Another possible explanation for this phenomenon may be that if a large number of applicants arrives the employer uses a two stage selection

process: first rough and then sophisticated. In the first rough and quick selection the employer reduces the size of the pool of applicants to manageable proportions. In the second sophisticated and time consuming selection the employer picks the most suitable applicant from the reduced pool. Large number of applicants arriving are not that important, as long as sufficient applicants arrive.

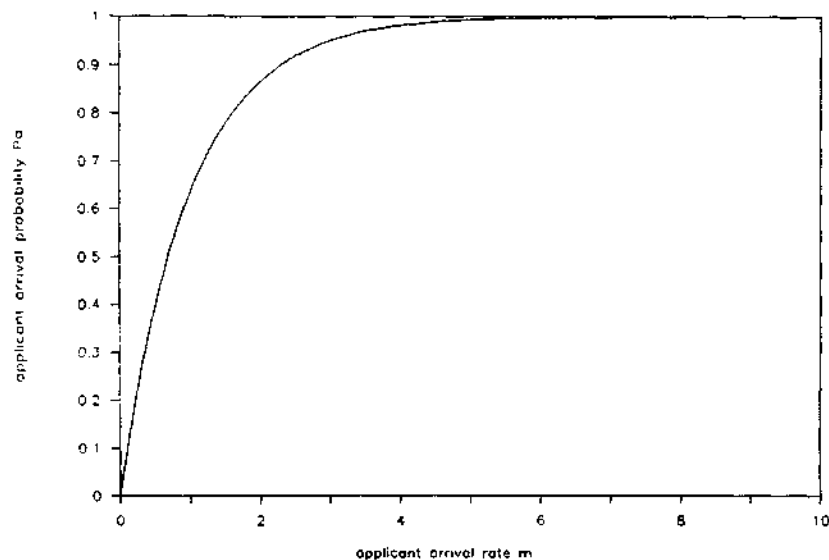
5.3 Vacancy durations and applicant arrival probabilities

If the total number of applicants arriving is not that important, it may be important whether or not one or more applicants arrive. There is of course a relation between m , the applicant arrival rate and P_a , the applicant arrival probability. If m is the parameter of a Poisson distribution then:

$$P_a(t) = P(k>0|t) = 1 - e^{-mt} \quad [15]$$

For a given t figure 6 shows the relation between m and P_a .

Figure 6 The relation between the applicant arrival rate m and the applicant arrival probability P_a



From this figure it is obvious that for values of m larger than 2 there is hardly any increase in P_a . In the analysis of m

the coefficients of the explanatory variables measure differences between m-values of 1 and 2 the same as between 10 and 11. In the analysis of P_a the coefficients are estimated to a large extent on the m-values between 0 and 2, because there is hardly any difference in P_a for m-values larger than 2. Exaggerating one could say that estimating m means differentiating between large and even larger m's, while estimating P means differentiating between small and even smaller m's.

A second employers search' model with selection procedures may be established as follows. Consider a job vacancy indexed by i, during an infinitesimal short period $(t, t+dt)$. The probability that during the interval $(0, t)$ one or more applicants arrived is $P_{a1}(t)$. $P_{p1}(t)$ is the probability one of the applicants in the pool is acceptable for the employer. Let $s_1(t)$ be the rate at which a suitable applicant is accepted from the pool of applicants. Then the probability a job vacancy is filled during $(t, t+dt)$, given it has been open for t periods, is (omitting the index i):

$$\theta(t)dt = P_a(t) \cdot P_p(t) \cdot s(t)dt \quad [16]$$

We may use information on durations to estimate $\theta(t)$ and information on applicants in the first stage of the survey to estimate $P_a(t)$. Again we cannot distinguish between $P_p(t)$ and $s(t)$ and we assume that in every pool of applicants there is at least 1 applicant suitable for the job. Then [16] becomes:

$$\theta(t)dt = P_a(t) \cdot s(t)dt \quad [17]$$

We may again use the information on vacancy durations to estimate $\theta(t)$ and use the information on the number of applicants as measured in the first stage of the survey to calculate $P_a(t)$, thus being able to estimate $s(t)$ as a residual of both. We specify s as a function of the same explanatory variables as before:

$$s(t) = s = \exp(X'\mu) \quad [18]$$

$$\begin{aligned} P_a &= P(k > 0 | t_1) = 1 - e^{-\mu t_1} && \text{for } t_1 < 2 \text{ weeks} \\ &= 1 - e^{-2\mu} && \text{for } t_1 > 2 \text{ weeks} \end{aligned} \quad [19]$$

Calculating P_a as in [19] means that if no applicant has arrived within the first 2 weeks no applicant will arrive at all and the vacancy will last forever.

The conditional probability density function of the completed vacancy durations is:

$$f_4(t_2 | t_1) = f_4 = \frac{P_a \cdot s \cdot \exp(-P_a \cdot s \cdot (t_1 + t_2))}{(1 - P_a) + \exp(-P_a \cdot s \cdot t_1)} \quad [20]$$

The appropriate likelihood is:

$$L = \prod_{j=1}^{f_c} (f_4) \prod_{i=1}^{f_1} \int_0^{t_3} (f_4) dt_2 \prod_{n=1}^u \int_{t_3}^{\infty} (f_4) dt_2 \quad [21]$$

The estimation results of [21] do not improve the estimation results shown in table 1. This means that allowing for the possibility that vacancies may last forever because no applicants arrive within the first 2 weeks does not improve our explanation of differences in vacancy durations. Again this may also be due to the fact the P_a is more important than we think.

5.4 Vacancy durations and applicant arrival intensities

Finally we estimated a simple hazard rate model in which some of the explanatory variables refer to applicant arrival intensities. In this model we used the following dummy-variables:

$d_1 = 1$, if $k=0$ on interval $0 < t_1 < 2$ weeks; $= 0$ otherwise

$d_2 = 1$, if $1 < k < 6$; $= 0$ otherwise

$d_3 = 1$, if $k > 5$; $= 0$ otherwise

The first dummy variable measures the effect of no applicants arriving for vacancies which originated shortly before the first stage of the survey. In this case there is still a possibility that applicants arrive. The second dummy variable measures the effect of 1-5 applicants arriving. The third dummy measures the influence of a large number of applicants

arriving.

We used the same likelihood functions as in [6] to estimate the influence of the three dummy variables. The estimation results are shown in the third column of table 5. From this table it appears there is some influence of the numbers of applicants arriving. If a job vacancy attract more than 5 applicants there is a significant shorter vacancy duration than if a vacancy attracts no applicants within the first 2 weeks of its existence. There is no significant effect of the dummy-variable representing the arrival of 1-5 applicants. So only a substantial number of applicants influences vacancy durations. In judging these results we have to keep in mind that we do not have information on the quality of the applicants. Apart from that the estimation results seem to suggest that vacancy durations are to a large extent determined by time consuming selection procedures. The numbers of applicants arriving have only a limited effect on vacancy duration.

6. Conclusions

From estimates of a reduced form model of employers' search it appears that durations of job vacancies depend to a large extent on required skills. The average duration of a job vacancy increases with the level of required education and working experience. Furthermore clerical/business vacancies last shorter than other vacancies.

Structural models of employers' search may be formulated in different ways. In this papers two different structural model were estimated. In the first there is a distinction between the applicant arrival rate and the applicant acceptance probability, based - amongst others - on the assumption that an employer decides immediately on the moment of arrival of an applicant whether or not the applicant is acceptable. This way an employer may use high applicant arrival rates to fill job vacancies quickly. From the analysis it appeared however that the size of the flow of applicants is not very important with respect to the duration of a job vacancy. Furthermore it

appeared that most applicants arrive within the first month of the vacancy, which itself may last substantially longer.

From these findings we concluded that it may be more realistic to model employers' search as a process in which employers pick applicants from a pool using a time consuming selection procedure. Therefore we estimated some simple structural models in which there is a distinction between the applicant selection rate and the numbers, probabilities or intensities of applicant arriving. The estimation results suggests that the duration of the job vacancy is influenced to a limited extent by the total number of applicants arriving. There are two possible explanations for this. One is that there is a variety of applicants in the pool, with large differences in productivities. The data however do not contain information on qualities of applicants, so we cannot check up on this. Another possible explanation for the phenomenon is that if a large number of applicants arrive the employer uses a two stage selection process: first rough and then sophisticated. In the first rough and quick selection the employer reduces the size of the pool of applicants to manageable proportions. In the second sophisticated and time consuming selection the employer picks the most suitable applicant from the reduced pool. Large number of applicants arriving are not that important, as long as sufficient applicants arrive. The analysis showed furthermore that a sufficient number of applicants means 'larger than five'.

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Appendix 1 Definitions of variables

Variables	Definition
. Clerical/business occ. (dummy)	Clerical, business or service occupation CBS-classification of occupations nrs. 3,4,5
. Industrial occupation (dummy)	Industrial occupation CBS-classif. of occupation nrs. 6,7
reference group: other occupations: CBS nrs. 0,2	
. Education required	Level of education based on CBS classification: primary: 1 academic level: 5
. Working experience required	Minimal required working experience in years/10
. Occupied job (dummy)	If the job is still occupied (first stage of the survey)
. Advertisement (dummy)	If an advertisement is placed (first stage of the survey)
. Employment office (dummy)	If the vacancy was reported to the public employment office (first stage)
reference group: other recruitment channels used	
. Testing procedure (dummy)	If a psychological or psychotechnical test is used in the selection procedure (first stage of the survey)
. Permanent contract (dummy)	If an permanent contract is offered to the new employee (first stage)
. Labour conditions (dummy)	Refers to a job with unpleasant working conditions like high temperatures, bad smells, dust etc.
. Part-time job (dummy)	If the job refers to a part-time position (first stage)
. Number of employees	Number of employees/1000
. Personnel department (dummy)	If the firm has a separate personal department
. Regional unemployment	Regional unemployment %/10

Appendix 2 Means of variables used in the analysis

Variables	Filled vacancies		Unfilled vacancies	Total
	duration precise	duration imprecise		
. Clerical/business occ.	0.49	0.40	0.27	0.42
. Industrial occupation	0.22	0.36	0.31	0.26
. Education required	2.98	2.98	3.30	3.06
. Working experience req.	1.44	1.61	2.08	1.62
. Occupied job	0.56	0.74	0.53	0.56
. Advertisement	0.58	0.68	0.58	0.59
. Employment office	0.30	0.36	0.34	0.31
. Testing procedure	0.25	0.22	0.39	0.29
. Permanent contract	0.64	0.70	0.64	0.65
. Labour conditions	0.27	0.18	0.21	0.25
. Part-time job	0.09	0.08	0.05	0.08
. Number of employees	0.38	0.78	0.50	0.44
. Personnel department	0.64	0.68	0.66	0.65
. Regional unemployment	1.41	1.40	1.40	1.40
Number of job vacancies	446	50	174	670