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AN EMPIRICAL ANALYSIS OF EMPLOYERS' SEARCH

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Abstract

In this paper employers' search is studied by using information about job vacancies. The rate at which vacancies are filled is split up in the product of the rate at which applicants arrive and the probability a random applicant is accepted by the employer. Both the applicant arrival rate and the probability an applicant is accepted appear to be influenced by variables like employers' size, required skills, recruitment channels and regional labour market conditions. Furthermore there is a positive duration dependence of the applicant acceptance probability and a negative duration dependence of the arrival rate of applicants.

1. INTRODUCTION

Employers with job vacancies to fill are engaged in search for new employees. Unemployed and some employees are engaged in search for (new) jobs. As Holt and David (1966) put it: 'The hiring of a worker is resulting from a random search process through which a non standard worker and a non standard job are somehow matched to satisfy certain wage and skill criteria established by firm and worker'. Search by workers and employers is an important adjustment mechanism of the labour market. In the theoretical developments and empirical research following the Holt and David study the emphasis was on job search. Lippman and McCall (1976) for example hardly pay any attention to employers' search.

Labour market search' studies are often focused on the job search of unemployed workers (Mortensen, 1986). The durations of unemployment spells are analyzed by applying hazard functions methods, which can be regarded as reduced forms resulting from behavioral models relying on job search arguments (Kiefer, 1988). See for the seminal papers: Salant (1977), Lancaster (1979), Nickell (1979). In the Netherlands empirical research on the duration of unemployment spells using hazard functions has been done on aggregate data (Kooreman and Ridder, 1983) as well as on micro-data (Van Opstal and Theeuwes, 1986).

The focus on job search using data on unemployment spells rather than on employers' search using job vacancy data may be attributed to a number of factors. There are conceptual and measurement problems connected to job vacancies. Data on unemployment spells are more abundant than on job vacancies. Furthermore on average the duration of job vacancies is short, so from policy point of view the duration of job vacancies is much less a concern than the duration of unemployment spells. Finally most labour markets are characterised by an excess supply which again focusses the attention on unemployment.

In the Netherlands until recently the only reliable vacancy data were the aggregate stock data from the Central

Bureau of Statistics with restricted information about incomplete durations of job vacancies. These aggregate data have been analyzed with a hazard function method from which it appeared that there are big differences in the completed durations depending on the characteristics of the job vacancies and the state of the labour market (Van Ours and Ridder, 1988).

Until now empirical studies on employers' search and job vacancies are scarce. The only studies using micro job vacancy data we know of are by Beaumont (1978) en 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. Studies on employers' search by Barron and Bishop (1985) and Barron, Bishop and Dunkelberg (1985) and Barron, Bishop and Dunkelberg (1987) used information from surveys in which employers were asked about their screening and interviewing activities associated with the last employee hired prior to the survey.

In this paper employers' search is analyzed using data from a Dutch job vacancy survey held in two stages in the period November 1986 - April 1987. In the first stage employers were questioned about their job vacancies. In the second stage, about four months later, employers were asked if their job vacancies had been filled in the meantime and if so they were questioned about the completed durations of the job vacancies, the characteristics of the new employee etcetera. In the analysis we use a hazard function method. The main difference with comparable analyses is that we split up the hazard rate at which vacancies are filled in the product of the rate at which applicants arrive and the probability a random applicant is accepted by the employer. We estimate the effect of the explanatory variables on both the arrival rate and the acceptance probability. In the analysis different types of explanatory variables are used: characteristics of the employer, required skills, characteristics of the vacant job, recruitment methods and regional labour market conditions.

The rest of the paper consists of the following sections. In section 2 the concept of a job vacancy is discussed and

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some information is given about job vacancies in the Netherlands. The modelling of employers' search is described in section 3. In section 4 we discuss data and variables used in the analysis. The estimation results are presented in section 5. The conclusions are summarized in section 6.

2. EMPLOYERS' SEARCH AND JOB VACANCIES

2.1. The concept of a job vacancy

Employers' search for new employees by means of job vacancies. The actual recruiting process of a new employee consists of three steps (Goodwin and Carlson, 1981):
- the employer collects applications from interested candidates who possess the general skills and attributes required for the job;
- through a selection process the employer narrows this general applicant pool to the person with the best job-specific skills;
- the applicant accepts the job offer (or not).
Job search' theory focuses on this third-step decision, employers' search is concerned with the first two steps of the recruiting process.

To obtain an initial pool of applicants the employer will actively solicit applications. Though some job seekers may apply without prior knowledge of the existence of a vacancy, generally an employer has to recruit actively. For that he can use formal recruitment channels like the public employment office or an advertisement in a newspaper, but he may also use an informal recruitment channel like employee referral. The problem facing the employer is not to get in touch with the largest possible number of potential applicants; rather it is to find a few applicants promising enough to be worth the investment of thorough investigation. (Rees, 1966).

The initial pool of applicants can be controlled by both hiring standard and choice of recruitment channel. Employers often have a strong preference for using informal recruitment channels, for a variety of reasons: they are costless, they

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provide good initial screening and they provide applicants from the neighborhood in which the firm is located. Furthermore they give potential applicants more information than an advertisement in a newspaper, which may improve the quality of the match between workers and jobs. It was found that those who had informal contact on their job prior to being hired are less likely to quit in the future, suggesting that they are more satisfied with their job (Datcher, 1983). Though friends, relatives and personal contacts are an important source of information and help to workers seeking jobs (Corcoran, Datcher and Duncan, 1980) a lot of employers use formal recruitment channels. These formal channels have their own advantages and disadvantages. State employment services are costless but there are frequent complaints about sluggishness and poor screening. Advertising is expensive for the employer but provides the job-searcher with low-cost information concerning the existence and location of a vacancy. Advertisements therefore generally attract many applicants, though not all of them are suitable for the vacant job. The actual choice of recruitment channel(s) depends on the characteristics of the vacant job and regional labour market conditions.

Employers' search behaviour can be studied by using information about job vacancies. Data on job vacancies are scarce which is not surprising considering the problems of concept and definition that must be solved. Data are often not collected to study employers' search, but to serve other purposes. In Canadian and American surveys for example a job vacancy was defined in a way to get a formal symmetry with the definition of unemployment. An unemployed worker is one who is not working and is actively seeking a job. Thus a vacant job is one which is not occupied and is actively seeking a worker.

In a 1966 Canadian pilot survey it was discovered that formal records from which an accurate count of job vacancies can be made seldom exist and that the responsibility for and knowledge of recruitment and hiring within large companies is frequently dispersed, both occupationally and geo-graphically. In the actual survey that was held anyway, a job vacancy was defined as a job that was vacant, for which some specific recruiting action was undertaken during a specified time period

and that was open to workers from outside the establishment (Boucek, 1975).

In the USA pilot programs for the collection of job vacancy data were started several times during and after World War II. Conclusions based on these pilots were the same as in Canada: very few employers keep a formal record of job vacancies (Joseph, 1965). Yet it was stated that it was feasible to measure job vacancies with a level of accuracy that would make the figures meaningful (Frumerman, 1978). In the period 1969-1973 monthly data about job vacancies were collected on a national scale as part of the JOLT-program, the Job Opening-Labor Turnover program. In december 1973 the job vacancy part was discontinued mainly for two reasons. The collected data could not be used for direct placement purposes and because only summary information was published, they could not serve research purposes. (See for some analyses of the pilot survey: Konstant and Wingeard (1968) and of the actual survey: Armknecht (1974)). In the American surveys there were three basic stipulations for an employment opportunity to be reported as a job vacancy: it had to be unoccupied, immediately available and the object of an active search for a new worker from outside the firm. (Frumerman, 1978). The criteria in the definition of job vacancies were designed to provide maximum comparability with the definition of unemployment. There was disagreement on all parts of this definition. Employers are often recruiting in anticipation of turnover and expansion, before jobs are actually vacated. The definition excludes vacancies for which an employer is willing to hire a worker, even though the worker will not normally begin work until a later time. The active search criterion eliminates job vacancies which exist but for which there has been no active searching because employers are discouraged by the absence of qualified applicants (Frumerman, 1978).

The definition of a job vacancy should be in line with the purpose of the analysis. If one is interested in job vacancies as a measure of not fulfilled demand one should exclude recruiting in anticipation of a future unoccupied job. If one is interested in the characteristics of employers' search behaviour it is not that important whether there is an

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unoccupied job or not. As is shown in the next section in the Netherlands job vacancy statistics deal with both occupied and unoccupied jobs. The major conceptual difference between job vacancies thus defined and unemployment is then the asymmetry between search by employers and search by persons. Search by persons currently employed is not counted in unemployment, while a search by employers is counted as a job vacancy whether there is an unoccupied job or not. If one is interested in employers' search this asymmetry is taken for granted.

2.2. Job vacancies in the Netherlands

Like in other EC-countries the basis of the regular information about job vacancies in the Netherlands consists of vacancies notified to the public employment service. In most EC-countries the employer has no obligation of notifying the public employment service, so notified vacancies are only a part of the actual number of vacancies. Overall in the UK it is estimated that about one third of all vacancies is notified to local employment offices, in France this is 20% and in Germany 27% (Walsh, 1982). Thus employers' search can hardly be analyzed by means of notified job vacancies only.

In the Netherlands information about job vacancies is also collected by the Central Bureau of Statistics (CBS) by means of an employers' survey, held almost every year since 1980. In this survey some 20.000 firms are interviewed about their job vacancies. Government, education and private employment agencies are excluded from the survey.

The first question of the CBS vacancy survey implicitly defines a job vacancy by asking the employer:

- 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?

So it is not important whether a job is occupied or not, nor is it necessary that the employee can be put to work immediately. This broad definition leads to inconsistencies if one wants to compare the figures with unemployment data, but as a means to study employers' search behaviour the information collected is valuable.

Some of the information from the most recent survey is presented in table 1. From this table it appears that in the beginning of 1988 half of the large firms in the Netherlands had job vacancies, a share which is much smaller in medium sized and small firms. Only 6.5% of the small firms had job vacancies. On a national level there were about 65.000 job vacancies (which one may want to compare with a number of registered unemployed of 680.000), of which some 40% were vacancies at small firms. The share of hard-to-fill job vacancies was about 40%. In the survey there is no definition of what a hard-to-fill job vacancy is, so the information on this item is subjective.

As is shown in table 1 on average one on three job vacancies refers to an occupied job. The share of these vacancies increases with the size of the firm. More than half of the vacancies in large firms refer to occupied

Table 1 Job vacancies in the Netherlands; 31 January 1988

	Size of the firm[a]			Average/ Total
	Small	Medium	Large	
Number of firms (*1000)	202.4	36.1	3.7	242.2
Firms with vacancies (%)	6.5	17.6	50.3	8.9
Number of vacancies (*1000)	24.8	16.9	22.9	64.5
Hard-to-fill vacancies (%)	44	46	37	42
Vacancies occupied jobs (%)	26	35	54	32
Part-time vacancies[b] (%)	25	20	18	21

a) Small: < 10 employees; Medium sized: 10-99 employees;
   Large: ≥ 100 employees
b) Job less than 20 hours per week

Source: Central Bureau of Statistics

jobs. So especially large firms are anticipating on job mobility and growth of employment in their search for new employees. Finally some 20% of the job vacancies refer to part-time jobs.

Not included in table 1 is information on recruitment channels. On average 36% of the job vacancies were reported to the public employment office and for 54% of the job vacancies one or more advertisements were placed.

The CBS vacancy survey contains aggregate information on incomplete durations of job vacancies. The question asked about

the duration is: How long ago did you start searching employees for this vacancy? The answer ismultiple choice with the alternatives: less than a month, 1 to 3 months, 3 to 6 months; 6 months or more. The share of job vacancy open for more than 3 months was 20%.

The information published by the CBS is on an aggregate level which leaves few possibilities for empirical analysis.

3. MODELLING EMPLOYERS' SEARCH

3.1. Search theory

We can analyze the duration of job vacancies using the results from the economic theory on search. In this theory, for given wage offers, employers searching for new employees face a distribution of marginal products related to job searchers (Lippman and McCall (1976) pp. 181,182). Of course productivities of job searchers are not easily determined. It is assumed that employers can perform tests which reveal the true value of the job searcher's marginal product. These tests are costly in time and money and it is these costs which amongst others limit the employer's search. Each time an applicant drops by, the employer has to decide whether to accept the applicant or to continue searching for another applicant with possibly better qualifications. If the employer decides to continue searching and the vacancy refers to an unoccupied job he forgoes income (the difference between the wage he wants to pay and the value of the potential production of the rejected applicant). Moreover, as stated before searching itself is not costless. The employer balances the costs of further search to find a better candidate against the extra profits connected to that candidate. He does this by choosing a level of productivity such that the marginal costs of another period of search is equal to the expected marginal income gain in this period. This productivity level is the reservation productivity of the employer. As soon as an applicant has an estimated productivity above the reservation-productivity he or she is hired.

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3.2. Filling job vacancies

In most cases an employer chooses a new employee from a pool of applicants. If this pool does not contain an acceptable applicant the employer continues searching until he can choose from another pool of applicants. In modelling employers' search we suppose that an employer decides whether or not an applicant is acceptable on the moment of arrival of that applicant. So there is no pool of applicants but the applicants are judged one by one.

Consider a job vacancy indexed by i, during an infinitesimal short period (t,t+dt). The arrival rate of applicants during this period is $m_i(t)dt$. If $q_i(k|t)$, $k = 0,1,..$, represents the probability an employer receives k applicants for vacancy i during a period of length t, then using a Poisson as a natural specification for the distribution:

$$q_i(k|t) = \frac{\left(\int_0^t m_i(s)\,ds\right)^k}{k!} \cdot e^{-\int_0^t m_i(s)\,ds} \qquad [1]$$

Employers draw applicants with productivity x from the distribution $f_i(x)$. When an applicant arrives, the employer decides whether to accept him (or her) or to continue searching. If an applicant is acceptable he or she is acceptable at the moment of arrival. 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:

$$P_i(t) = \int_{x_i^*(t)}^{\infty} f_i(x)dx \qquad [2]$$

If the distribution of productivities corresponding to possible applicants is given by the distribution function $F_i(\cdot)$, then 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:

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$$\theta_i(t)dt = m_i(t).(1 - F_i(x^*_i(t)))dt \qquad [3]$$

Roughly the hazard rate is the rate at which vacancies are filled at duration t, given that they last until t. The relation between the hazard rate and the probability density function g(t) is (dropping the index i):

$$\theta(t)dt = g(t)dt \,/\, (1 - G(t)) \qquad [4]$$

in which G(t) is the corresponding distribution function of the completed job vacancy durations. Integrating [4] gives:

$$\int_0^t \theta(s)ds = - \ln(1 - G(t)) \qquad [5]$$

So:

$$1 - G(t) = e^{-\int_0^t \theta(s)ds} \qquad [6]$$

Combining [4] and [6] we get the standard result:

$$g(t) = \theta(t) \,.\, e^{-\int_0^t \theta(s)ds} \qquad [7]$$

If we have information about completed job vacancy durations we can estimate $\theta(t)$ from [7]. It is clear that we can only study [3] if we have additional data on reservation productivities or arrival rates of applicants. Exact data about reservation productivities used by employers in their search for new employees are not available. We do however have information about applicants, which we can use to estimate arrival rates. We therefore rewrite the hazard rate as:

$$\theta(t) = m(t) \,.\, P(t) \qquad [8]$$

where P(t), the probability of an applicant being acceptable can be estimated as a resultant of $\theta(t)$ and m(t).

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4. DATA, VARIABLES

4.1. 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. In the survey the description of the Central Bureau of Statistics of what is to be considered as a job vacancy was used.

The sample of 1913 employers 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 sample is stratified according to employers' size and economic activity. Medium sized establishments had a smaller sample fraction than large establishments. In the sample there were 1288 medium sized and 625 large employers.

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 them. Of the 648 employers with job vacancies 580 gave their full cooperation. These employers answered to questions 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.

The second stage of the survey was held some four months later. Of the 580 employers of the first stage 550 participated in the second stage. Employers were asked if the job vacancies of the first stage had been filled and if so they were questioned about them. Questions were asked about the skills of the new employee, the labour market position he or she came from, the completed duration of the job vacancy and so on.

Employers were questioned about single and multiple vacancies. By the latter we mean a job vacancy for which the

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employer is searching more than one applicant with the same required skills. Multiple vacancies are excluded in the analysis because the numbers of applicants connected to these vacancies refer to more than one vacant job. Furthermore 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. Of course estimating the applicant arrival rate only over the first interval means that combinations may occur of zero applicants in the first stage and filled vacancies in the second stage of the survey.

One can argue about the definition of job vacancy duration, because it is not clear at what moment in time a vacancy is filled: the moment an employer comes to an agreement with an applicant or the (later) moment a new worker starts on the job. In this analysis we choose the first moment because that is when employers' search stops. The durations of the job vacancies were calculated using questions about the date of origination and the date the vacancy was filled. These data were not reported by the day of the month, but as start, middle or end of a certain month.

After discarding observations for which essential variables are missing or for which the information about uncompleted or completed duration is judged unreliable a sample of 719 job vacancies remains, 166 of which were still open in the second stage. In the remaining sample there are two sorts of filled job vacancies: those on which we have exact information from the second stage and those of which we know from the second stage only that they were filled between the two stages. Of the first type of job vacancies we know the exact duration, of the second type we know an interval in which they were filled. In the remaining sample there are 490 job

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vacancies of the first type and 63 job vacancies of the second type.

4.2. Explanatory variables

Both the arrival rate of applicants and the probability an applicant is acceptable are influenced by various factors. Of the effect of some of these factors we have a priori expectations based on other research, theoretical grounds or intuition. Of some factors we have a priori expectations. Unfortunately we do not have information about the wage offer. We distinguish six groups of explanatory variables:

a. <u>Characteristics of the employer</u>: Larger employers are expected to 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. We expect that larger employers have a more thorough selection procedure, so the probability of an applicant being accepted is smaller. Because for larger employers recruiting is a regular phenomenon we expect larger employers to be able to attract a larger flow of applicants.

b. <u>Required skills</u>: Job vacancies differ in educational and work experience requirements. The influence of educational requirements on the of applicants is twofold. On the one hand lowly educated workers are more abundant in the labour market than highly educated workers, because the unemployment rate of lowly educated workers is relatively high. On the other hand highly educated workers have a high labour mobility, so the flow of workers from job to job is relatively large among highly educated workers. We expect the first effect to be dominant, so the higher the educational requirement the smaller the flow of applicants. The same holds for the required work experience. Many of the unemployed have only recently entered the labour market and are therefore without work experience. So we expect that job vacancies requiring no work experience attract more applicants. Employers are not only interested in level of education or work experience. For a good match between job and employee it is necessary to establish the correct value of the education and work experience of the applicants. This

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means screening and interviewing applicants. We expect that the higher the required education and the larger the required work experience the more intensive the selection procedure and thus the smaller the probability that an applicant is accepted by the employer.

c. Other characteristics of the vacant job: Besides required skills the vacant job is characterized by type of occupation and labour conditions. Industrial occupations may have different probabilities of applicants reacting or being acceptable than for example service occupations, though it is hard to predict which way it will go. Labour conditions refer to more or less unpleasant circumstances in which the job has to be done like for example high temperatures, dust, bad smells or when the work is on the assembly-line or working hours are irregular. We expect a smaller flow of applicants if there are unpleasant working conditions. We have no a priori prediction as to the effect on the probability that an applicant is accepted by the employer, but maybe because of the unpleasant working conditions the employer is more inclined to accept an applicant as being suitable for the job.

d. Recruitment channels: Employers 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. On the contrary a lot of employers use more than one channel. As stated before the effec-tiveness of the recruitment channel differs. Advertising and reporting to the public employment office will attract all sorts of applicants. Of course also the quality of the advertisement may be important, but we have no information on this. We expect that advertising and reporting to the public employment office will lead to a larger flow of applicants but with smaller acceptance probability. It is the other way around with informal recruitment channels and recruiting within the firm. Informal recruiting reaches less potential applicants but gives more exact information about the vacant job to the potential applicant and will reach only those potential applicants who are expected to have a great ability

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for the job. The same applies to recruiting within the firm. We expect with informal and internal recruitment a smaller flow of applicants but a larger acceptance probability.

e. <u>Regional labour market conditions</u>: When regional unemployment is high there is a large potential reservoir of applicants. We therefore expect the flow of applicants to increase with regional unemployment. We have no prediction of the influence of regional unemployment on the probability that an applicant is acceptable, but the state of the labour market may induce less suitable applicants to react thus reducing the probability that an applicant is acceptable.

f. <u>Duration dependence</u>: The duration of a job vacancy may influence recruitment intensity and reservation productivity of the employer. We are not certain of the kind of relation between duration and search intensity. On the one hand employers may increase their search in order to increase the flow of applicants, on the other hand much recruitment-efforts may be restricted to the start of the job vacancy. We therefore have no prediction about the effect of duration on the flow of applicants. Reservation productivity will decrease as it takes more time to fill the job vacancy because of a possible initial misjudgment of the actual labour market situation. As time passes on employers learn more about this situation and therefore decrease their reservation productivity. So the probability an applicant is accepted by the employer will increase in time. A positive duration dependence for the overall hazard rate was found in analysis of micro-data (Van Ours, 1988), as well as aggregate data (Van Ours and Ridder, 1988) on job vacancies.

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

5. ESTIMATION AND RESULTS

5.1. Econometric modelling and the likelihood function

As has been discussed in section 4.1 we have information from a two-stage job vacancy-survey. We know the incomplete

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duration of the job vacancies and the number of applicants from the first stage and the completed duration of the job vacancies from the second stage.

Due to length-biased sampling the probability density function of the uncompleted vacancy-durations is (Ridder, 1985):

$$f_1(t_1) = e^{-\int_0^{t_1} m(s).P(s)ds} \cdot \frac{1}{E(t)} \quad [9]$$

where: t_1 = the incomplete duration of the job vacancy at the first interview
$E(t)$ = the expected value of the completed duration

The number of applicants in the interval from the start of the job vacancy till the first stage of the survey is assumed to follow a Poisson distribution. Thus the conditional probability density function of the number of applicants is:

$$f_2(k|t_1) = \frac{(\int_0^{t_1} m(s) ds)^k}{k!} \cdot e^{-\int_0^{t_1} m(s) ds} \quad [10]$$

where: k = the number of applicants

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

$$f_3(t_2|t_1) = \frac{m(t_1+t_2).P(t_1+t_2).e^{-\int_0^{t_1+t_2} m(s).P(s)ds}}{e^{-\int_0^{t_1} m(s).P(s)ds}} \quad [11]$$

where: t_2 = the time between the first interview and the job vacancy being filled; the completed duration of the job vacancy = $t_1 + t_2$

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

$$g(t_1,t_2,k) = f_2(k|t_1) \cdot f_3(t_2|t_1) \cdot f_1(t_1) \quad [12]$$

We have information with respect to durations of three types of job vacancies:
- job vacancies filled between the first and second stage with

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exact information about the duration; completed duration = $t_1 + t_2$

- job vacancies filled between the first and second stage with no precise information about the duration; t_1 < completed duration < $t_1 + t_3$ in which t_3 = time elapsed between the two stages of the survey

- job vacancies still open at the second stage of the survey; completed duration > $t_1 + t_3$

The appropriate likelihood for our sample is:

$$
L = \prod_{j=1}^{fc} g(t_1,t_2,k) \cdot \prod_{i=1}^{fi} \int_0^{t_3} g(t_1,t_2,k)dt_2 \cdot \prod_{n=1}^{u} \int_{t_3}^{\infty} g(t_1,t_2,k)dt_2 \quad [13]
$$

where: fc = number of filled job vacancies in the sample with precise information about the duration

fi = number of filled job vacancies in the sample with imprecise information

u = number of unfilled job vacancies in the sample

In the analysis we made both m and P dependent on explanatory variables. We used three combinations of functional forms for m and P, which are presented in table 2.

In our first two estimations there is no duration-dependence and m is specified as $\exp(X'\mu)$. In the first estimation P has a logit specification, so it is difficult to model duration dependence. From the estimation results it appears that the acceptance probability is on average quite small.

Table 2 <u>Functional forms of m and P used in the estimations</u> [a]

1	$m = \exp(X'\mu)$ $\quad P_1 = \exp(X'\beta)/[1 + \exp(X'\beta)]$
2	$m = \exp(X'\mu)$ $\quad P_2 = \exp(X'\beta)$
3	$m(t) = \alpha_1 \cdot t^{\alpha_1 - 1} \cdot \exp(X'\mu)$ $\quad P_3(t) = \alpha_2 \cdot t^{\alpha_2 - 1} \cdot \exp(X'\beta)$

a) X: set of explanatory variables
μ, β: coefficients to be estimated
α_1, α_2: parameters of Weibull-distribution; $\alpha_1 > 0$, $\alpha_2 > 0$

We therefore use in our second estimation an approximation of

the logit specification and estimated P as $\exp(X'\beta)$. The disadvantage of this specification is obvious: P is no longer restricted to a value between 0 and 1 but can obtain a value larger than 1. The advantage of the specification is that it is possible to model a Weibull specification of duration dependence, which we did in our third estimation.

For the estimations we used the program GRMAX written by Geert Ridder.

5.2. Estimation results

The estimation results are presented in table 3. We will first discuss the results of the three estimates and then the coefficients of the explanatory variables.

Comparing the first two estimations we see that the approximation of the logit specification of P hardly influences the results. Comparing the second with the third estimation we see that both duration dependence coefficients are highly significant and the overall estimation result is much better than without incorporation of duration dependence. The arrival rate of applicants has a negative duration dependence; the acceptance probability has a positive duration dependence. So the flow of applicants decreases in time and the probability an applicant is accepted increases in time. The latter is consistent with our expectation of a decreasing reservation productivity of the employer. Because $(\alpha_1 + \alpha_2 - 1) > 1$ there is an overall positive duration dependence of the hazard rate, which confirms other estimation results (Van Ours, 1988).

When discussing the coefficients of the explanatory variables we use the third specification. Looking at the coefficient of the applicant arrival rate we see that some coefficients confirm our expectations while others do not. In line with our expectations is that vacancies requiring work experience attract less applicants than vacancies requiring no work experience. Advertising attracts significantly more applicants than other recruitment channels, while informal recruitment attracts fewer applicants. The flow of applicants from the public employment office and internal recruitment hardly differs.

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Table 3 <u>Estimation results</u> [a]

	Arrival rate applicants (per week) [m]	Probability of applicant being acceptable [P_1]	Arrival rate applicants (per week) [m]	Probability of applicant being acceptable [P_2]	Arrival rate applicants (per week) [m(t)]	Probability of applicant being acceptable [$P_3(t)$]
UNEMPL	0.03 (0.06)	0.11 (0.18)	0.05 (0.06)	0.09 (0.16)	0.02 (0.06)	0.11 (0.17)
SERVIC	0.54 (0.03)**	-0.31 (0.09)	0.54 (0.03)**	-0.28 (0.08)**	0.35 (0.03)**	-0.05 (0.08)
INDUST	0.11 (0.04)**	-0.20 (0.12)	0.11 (0.04)**	-0.20 (0.11)	0.15 (0.04)**	-0.27 (0.11)**
PRIMED	-0.98 (0.08)**	1.36 (0.22)**	-1.00 (0.09)**	1.09 (0.16)**	-0.85 (0.08)**	0.94 (0.17)**
EXTEDU	-0.12 (0.05)**	0.26 (0.14)*	-0.12 (0.05)**	0.26 (0.12)**	-0.08 (0.05)	0.23 (0.12)*
HIGHED	-0.42 (0.03)**	0.13 (0.09)	-0.41 (0.03)**	0.12 (0.08)	-0.02 (0.03)	-0.36 (0.08)**
LITEXP	-0.05 (0.03)	0.02 (0.10)	-0.04 (0.03)	-0.01 (0.08)	-0.06 (0.03)*	0.00 (0.09)
MUCEXP	-0.04 (0.03)	-0.11 (0.10)	-0.04 (0.04)	-0.11 (0.08)	-0.07 (0.03)**	-0.10 (0.09)
ADVERT	1.28 (0.03)**	-1.49 (0.09)**	1.29 (0.03)**	-1.28 (0.07)**	1.37 (0.03)**	-1.36 (0.07)**
EMPLOF	0.06 (0.03)**	-0.12 (0.08)	0.06 (0.03)**	-0.10 (0.07)	0.11 (0.03)**	-0.16 (0.07)**
INTREC	0.23 (0.03)**	-0.21 (0.08)**	0.23 (0.03)**	-0.19 (0.07)**	0.18 (0.03)**	-0.13 (0.07)*
INFORM	-0.32 (0.03)**	0.19 (0.08)**	-0.32 (0.03)**	0.17 (0.07)**	-0.13 (0.03)**	0.06 (0.08)
LABCON	0.04 (0.03)	-0.04 (0.08)	0.04 (0.03)	-0.03 (0.07)	0.11 (0.03)**	-0.09 (0.08)
SIZEFI	-0.01 (0.00)**	0.01 (0.01)*	-0.13 (0.02)**	0.09 (0.05)*	-0.11 (0.02)**	0.06 (0.05)
CONSTA	-0.88 (0.10)**	-1.25 (0.30)**	-0.91 (0.10)**	-1.47 (0.26)**	0.87 (0.11)**	-2.54 (0.34)**
α	-	-	-	-	0.12 (0.01)**	2.15 (0.06)**
- Logl.	10664		10663		8916	

Standard errors between parenthesis
**: Significant at 5% level
* : Significant at 10% level

a) See appendix 1 for the definitions of the explanatory variables

Furthermore service occupations attract the largest flow of applicants, while industrial occupations attract more applicants per vacancy than the other occupations. Contrary to our expectations regional unemployment does not influence the flow of applicants, while larger firms seem to attract less applicants. A striking result is that job vacancies on the lowest education level attract significant less applicants than job vacancies requiring more education. Also surprising is that jobs with unpleasant working conditions attract more applicants than other jobs.

The estimation results with respect to the acceptance probability to a large extent confirm our expectations. We see that the higher the required education the smaller the acceptance probability. Furthermore advertising is the least selective as a recruiting channel, while reporting to a public employment office also leads to a small applicant acceptance probability. Informal recruitment leads to the largest acceptance probability. There appears to be no influence from regional unemployment, required experience and size of the firm on the probability an applicant is accepted. Finally vacancies for industrial occupations have a significant lower acceptance probability than other occupations.

To give an impression of the influence of some of the explanatory variables table 4 shows some predicted numbers of applicants, acceptance probabilities and average completed job vacancy durations, based on the results of the third specification.

From this table it appears that the average number of applicants increases very slowly with the duration of the job vacancy, while the acceptance probability is increasing fast. The small increase in number of applicants may be due to an incorrect specification of duration dependence. Negative duration dependence appears to be better than no duration dependence, but perhaps a Weibull specification is not the most suitable one. Another possibility is that the arrivals of applicants is not Poisson distributed, because the use of recruitment channels is endogenous: search intensity may increase if the job vacancy lasts too long.

Table 4 Predicted probabilities and job vacancy durations[a]

	Average number of applicants after:		Probability of applicant being accept able after:		Average duration (weeks)
	two weeks	four weeks	two weeks	four weeks	
Service occupation Level of education					
Primary	5.7	6.2	0.29	0.65	8.0
Extended primary	12.3	13.4	0.14	0.32	7.6
Secondary	13.4	14.5	0.11	0.25	8.6
High vocat/acad	13.1	14.2	0.08	0.18	11.6
Non-serv. occup. Level of education					
Primary	4.0	4.0	0.31	0.68	10.2
Extended primary	8.7	9.4	0.15	0.33	9.7
Secondary	9.4	10.2	0.12	0.27	10.9
High vocat/acad	9.2	10.0	0.08	0.19	14.7

a) Other variables: No working experience required, no unpleasant working conditions, firm with 100 employees, regional unemployment 14.2%, recruitment channel: advertisement

The main difference between service and other occupations is the difference in arrival rate of applicants, the acceptance probability is practically the same. Looking at the influence of the required education we see that the big difference in applicant arrival rates is between primary education on the one hand and all higher educational levels on the other hand. The acceptance probability is rapidly decreasing with the level of required education. After two weeks job vacancies for service occupations requiring primary education have an acceptance probability of 31%, while this is 8% when higher education is required. Average calculated durations of the job vacancies vary from 7.5 to 15 weeks. Except for job vacancies requiring no education, the higher the education required, the longer the duration of the job vacancy.

6. CONCLUSIONS

The results of modelling employers' search by using information on job vacancies are encouraging. The rate at which vacancies are filled can be split up in the applicant arrival rate and the probability an applicant is acceptable, both of which appear to be influenced by variables like required skills, employers' size and recruitment channels. Quite a number of estimated effects of these variables are as one would expect.

Looking at the excess-supply on the labour market which is especially large among low skilled workers, one of the more striking results of this analysis is that regional unemployment has no effect on the flow of applicants, while the flow of applicants is smallest when there is practically no education required.

Furthermore both the applicant arrival rate and the probability an applicant is acceptable are duration dependent. The positive duration dependence of the applicant acceptance probability is consistent with a declining reservation productivity of the employer, while the negative duration dependence of the arrival rate of applicants is not unrealistic. However only a few specifications of duration dependence in both cases have been investigated so these results are by no means definite. Some topics for future research are: using other specifications for the arrival rate of applicants, using more information about recruiting channels, taking into account the possibility of endogeneity of recruitment, correcting for possible unobserved heterogeneity. Continued research will lead to more detailed information concerning the nature, the determinants and the effectiveness of employers' search.

APPENDIX 1: DEFINITION OF VARIABLES

The independent variables are defined as follows.

Dummy variables: equal to one if:

Occupation (Classification of Occupations 1984, CBS)
SERVIC: service, administrative, commercial occupation
(CBS 3,4,5)
INDUST: industrial (blue collar) occupation (CBS 6,7)
Reference group: other occupations (CBS 0,2)

Education (minimum level required)
PRIMED: primary level
EXTEDU: extended primary level, vocational schooling
HIGHED: higher academic or vocational schooling
Reference group: education at extended primary level,
general schooling and education at secondary level

Working experience (minimum level required)
LITEXP: less or equal to 2 years
MUCEXP: more than 2 years
Reference group: no working experience required

Recruitment channels (situation at the first interview)
ADVERT: advertisement
EMPLOF: reported to public employment office
INFORM: one or more informal recruitment channels
INTREC: internal recruitment used
No reference group; because firms may use more than one
recruitment channel separate dummy variables are used

Labour conditions
LABCON: job with unpleasant working conditions, like: high
temperatures, dust, bad smells, assembly-line
work, irregular working hours
Reference group: job without the unpleasant working
conditions mentioned above

Continuous variables:

SIZEFI: number of employees (*1000)
UNEMPL: unemployment percentage in the province of the
employer (*10)

APPENDIX 2: MEANS OF VARIABLES USED IN THE ANALYSIS

	Total sample	Filled (precise information)	Filled (imprecise information)	Unfilled
UNEMPL(10 %)	1.42	1.42	1.42	1.41
SERVIC	0.433	0.478	0.540	0.259
INDUST	0.253	0.233	0.270	0.307
PRIMED	0.049	0.057	0.048	0.024
EXTEDU	0.134	0.141	0.111	0.120
HIGHED	0.337	0.304	0.222	0.476
LITEXP	0.342	0.355	0.460	0.259
MUCEXP	0.405	0.357	0.349	0.566
ADVERT	0.590	0.584	0.651	0.584
EMPLOF	0.359	0.347	0.397	0.380
INFORM	0.707	0.698	0.698	0.735
INTREC	0.616	0.608	0.587	0.651
LABCON	0.274	0.288	0.222	0.253
SIZEFI (*1000)	0.448	0.378	0.804	0.520
t_1 (weeks)	9.3	8.9	8.5	11.1
t_2 (weeks)	-	16.7	-	-
t3 (weeks)	17.4	17.5	17.3	17.3
k	11.7	12.5	10.8	9.7
NUMBER OF OBSERVATIONS	719	490	63	166

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