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Vacancy Duration on Regional Labour Markets in the Netherlands

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ABSTRACT.

The focus of this paper is on the functioning of regional labour markets from a demand-side perspective. In this respect, vacancy duration is the natural measure of the tightness of the (regional) labour market. The determinants of vacancy duration are studied in the context of a new theoretical model of employer's search behaviour. The model is empirically applied for the Netherlands by specifying its reduced form as a mixed proportional hazard model. Special attention is paid to the sensitivity of the estimation results for the specification of the base-line hazard (duration dependence) and the distribution of the error term (unobserved heterogeneity). The model is tested by means of an unique data set on employers' search behaviour.
It is found that vacancy duration is considerably longer if a high educational level and/or specific work experience is required, indicating that there may exist a shortage of workers with specific qualifications on the Dutch labour market. The effect of the regional environment on vacancy duration appears to be less important than expected, whilst the use of advertisements as a search method for applicants has a large significant positive effect on vacancy duration.
Finally, Dutch vacancies appear to be positive duration dependent which does not necessarily stem from an adjustment in the hiring standard of employers, but may also be caused by the pattern of the arrival- and screening process of applicants.

INTRODUCTION.

In the beginning of the 80's unemployment has shown a dramatic growth in the Netherlands (in absolute numbers from 325,000 in 1980 to 820,000 in 1984). For many people who lost their job it turned out to be extremely difficult to become re-employed again: The duration of unemployment has increased enormously (from about 8 months in 1980 to about 20 months in 1984). This rise in unemployment duration has of course far reaching consequences for the economic and social well-being of the unemployed.

In order to identify appropriate policies for this problem, the nature of long-term unemployment has been investigated in a large number of studies. These studies have mainly tried to find explanations for the phenomenon of long-term unemployment on the basis of the search behaviour and labour market characteristics of unemployed individuals. At the micro level, many statistical models (using inter alia hazard function methods) were developed with the aim to investigate the determinants of the duration of unemployment (see e.g. the pioneering studies of Lancaster, 1979 and Nickell, 1979).

Since the mid 80's the situation on the Dutch labour market, reflected by the growth of employment (from -2% in 1982/83 to 4% in 1985/86), has remarkably improved. In contrast to this upswing in labour demand, the reduct'on of unemployment is still very modest in recent years due to the large number of new entrants on the labour market. There is still a significant lack of specific job opportunities for certain categories on the Dutch labour market.

Another indication of the increase in labour demand in the Netherlands is the growth of the number of unfulfilled jobs (from 20,000 in 1983 to 70,000 in 1989). Moreover, employers' associations complain about vacancies that are hard to fulfil. So, there is apparantly an increasing mismatch of demand and supply on the Dutch labour market.

Labour market phenomena (reflected by unemployment, employment growth, vacancies, etc.) can be studied in various ways. We distinguish the following four dimensions. First, discrepancies on the labour market can be examined at either an individual or aggregate level. Secondly, different analytical methods can be used, e.g. static or dynamic approaches. The latter approach is preferable if one wants to take into account the interactions between labour market stocks and flows (see for example Holt and David, 1966). Thirdly, labour market research can be carried out on the basis of supply-side or demand-side oriented approaches. Finally, one can examine labour market phenomena at different spatial aggregation levels (national versus regional).

Untill now, most empirical labour market research at the micro level has mainly focussed on supply side indicators such as the duration of unemployment. Much less attention is usually paid to demand side indicators of the functioning of the labour market: notably the number of vacancies and vacancy duration. This is not surprising since data on vacancies are rather weak or absent in most countries. For the Netherlands, vacancy duration has been studied by Van Ours and Ridder, 1988, Van Ours, 1989 and 1990 and Renes, 1989.

In our paper, we study the determinants of vacancy duration in a **spatial** perspective by using micro data on vacancy durations for different regions in the Netherlands. It is important to pay attention to the spatial dimensions of labour market processes because of several reasons (see for example Fisher, 1986). The mismatches between the demand for and the supply of labour in the Netherlands may - among other reasons - be caused by frictions of distance and the resulting problems of market coordination and information. Moreover, differences in the economic structure of the various regions in the Netherlands may lead to strong spatial variations in the dynamics of vacancies. To the same extent that the duration of unemployment is a reflection of the tightness of a regional labour market from a supply-side perspective, vacancy duration may be seen as the natural measure of the tightness of the regional labour market from the side of the firm (see also Jackman et al., 1984).

Identification of the determinants of the length of the spell of a vacancy may suggest the formulation of policies aiming at reducing vacancy duration. This will reduce the productive loss for the firm and the level of unemployment.

Thus by studying the determinants of vacancy duration, one may obtain a better insight in (see also Van Ours, 1989):

- the functioning of the regional labour market..
  Vacant jobs with a short duration might indicate a surplus of workers suitable to fulfil these jobs, whilst vacancies which are hard to fill point out that there might be a shortage of workers who could be hired for these jobs.
- the possibilities for the firm to shorten the duration of their vacancies.
  By using different search methods (or alternative selection and screening procedures), the employer will be able to shorten the duration of vacancies and hence reduce both the costs of the recruitment procedure and the actual productive loss.

We will investigate successively the determinants of vacany duration using different types of explanatory variables (analogous to Van Ours, 1989):

(a) recruitment channels
(b) regional environment
(c) characteristics of the vacant job and the firm

The use of different **recruitment channels** may be an important tool of employers' recruitment behaviour, because (according to Roper, 1988) the characteristics of the job (including the wage rate) may be fixed as will be the labour market environment from which the firm has to recruit so that the firm's largest remaining area of discretion is its choice of recruitment channels. The conclusion of Roper for British data is that the choice of recruitment channels dominates all other identified characteristics of the vacancy in terms of the size of their effect. We will in our paper estimate the relative importance of the choice of recruitment channels made by employers on vacancy duration for the Dutch labour market.

Secondly, it is interesting to examine the effect of **regional labour market conditions.** In Beaumont (1978), it was found that the tightness of the local labour market is an important determinant of vacancy duration. The geographical position of the firm may thus be an important determinant of vacancy duration. In order to test the effect of regional labour market conditions, we will use two approaches.

a) The first approach is based on identifying the effect of the structure of the regional labour market. We will distinguish two labour market areas in our model of vacancy duration, namely the urban and the rural labour market. The structure of the regional economy differs considerably between urban and rural areas and this will be reflected in the type of jobs becoming vacant and in the qualifications of the applicants willing to fulfill these jobs. In our approach, we want to test whether there is an effect of the regional environment (classified according an urban and rural dichotomy) on the duration of vacant jobs.
b) In the second approach, we will use the local unemployment rate as an indicator of the tightness of the local labour market of the firm. In this analysis, we will exclude vacancies requiring highly educated applicants, because we expect that in this case the relevant search area is much wider than the local labour market (for example, due to the use of advertisements in national newspapers).

Thirdly, we are interested in the influence of the **type of job and firm** as can be found from the empirical evidence on vacancy duration (see also Renes, 1989). For different types of jobs, different supply-demand ratios will be observed, leading to differences in vacancy duration. One must note, however, that the vacancy duration may be biased by the (usually unobservable) differences in the duration of selection and screening among different types of jobs. For example, if we find that the duration of vacancies is long for jobs requiring highly educated applicants, there might be a shortage of highly educated workers but it might also be true that the selection procedure (advertizing, screening, etc) takes more time for this type of jobs.

Finally, we will also examine whether there is an autonomous positive duration effect on vacancy duration (while controlling for the effect of unobserved characteristics). This could mean that employers are learning over time about the posssibilities to fulfil their jobs and adjust their hiring standards accordingly (for example, the requirements for the applicants or the search methods).

The paper is organized as follows. In section 2, we will discuss the search behaviour of employers. Starting from the traditional optimal search model, we will present an alternative - non sequential -formulation of employers' search behaviour. The resulting statistical model will be introduced in section 3 and will be used to analyze our duration data for the Netherlands. After discussing the explanatory variables of the model, we will present the estimation results in section 4. In the next section, it will be tested whether the estimated model is not misspecified. Finally, a summary of the approach of the paper and some concluding remarks will be presented in section 6.

2. EMPLOYERS' SEARCH BEHAVIOUR: A THEORETICAL VIEW.

In this section, we will discuss the economic theory of employers' search and its implications for duration models of job vacancies (analogous to the more familiar theory of job search, see Lippman and McCall, 1976).

In job search theory, jobs are offered by the employer to job searchers and for each offer the job searcher has to decide to accept the offer or not. This decision will depend on the wage associated with the job and the minimum wage for which the searcher is willing to work (reservation wage). The level of the reservation wage is found by balancing the marginal costs of search against the expected marginal benefits of finding a better paid job. The job searcher will accept an offer if the wage of the job exceeds the reservation wage.

In the theoretical model of employers' search, applicants apply for vacancies of employers and for each applicant the employer has to decide whether he or she accepts the applicant. This decision will depend on the expected marginal productivity of the applicant and the minimum productivity for which the employer is willing to accept (reservation productivity). The marginal productivity of the applicant is estimated by performing (costly) tests and it is these costs which (among others) limit the employers' search. The level of the reservation productivity is found by equalizing the marginal costs of further search for better qualified applicants against the expected marginal increase of profits due to the higher productivity of that candidate. The employer will accept an applicant if the expected productivity of the applicant exceeds the minimum required level (i.e. the reservation productivity).

In the context of optimal employers' search, the recruitment process of the employers can be modelled by a so-called "hazard rate" approach in which the hazard is defined as the intensity at which vacancies are fulfilled. The hazard rate is the product of

i) the applicant arrival rate (m_i)
ii) the probability that the employer will accept an applicant

Thus we get

$$\delta_i(t) = m_i(t) * [1-P(R_i)] \qquad (1)$$

with

$\delta_i(t)$ = the hazard rate
$P(.)$ = the distribution function of productivities corresponding to potential applicants
R_i = the reservation productivity

Usually, it is hard to identify the arrival rate and the acceptance probability, because there is no (reliable) data on the number of applicants or the reservation productivity of the employer (for an exception, see the study of Van Ours (1990) in which the number of applicants is known). Moreover, this structural approach of modelling employers' search can be critisized by various arguments. In our view, the most serious drawback is that it is formulated as a **sequential** choice process.

In this paper, we will start from an alternative structural model of employer's search behaviour. Employers usually consider a group of applicants simultaneously and next, they select the "best" applicant on the basis of a set of qualifications. Finally, the employer decides whether the applicant is acceptable. If no acceptable applicant is found, then the employer continues to search and the selection procedure may start again.

In order to model this kind of recruitment behaviour, we will use the following formulation. A vacant job is not fulfilled at time t if there was no acceptable applicant found in the period (0,t). This can be written as follows.

Pr[vacancy i is not fulfilled at time t] =

Pr_{it}[no applicants arrived in period (0,t)] +

Pr_{it}["best" applicant (screened before t) was not acceptable] =

$$\sum_{n=0}^{N} [\ Pr_{it}(A_n) * \sum_{k=0}^{n} (\ Pr_{it}(B_{k|n}) * Pr_{it}(C_k)\ )\ ] \qquad (2)$$

with

$Pr_{it}(A_n)$ = Pr[# applicants arrived in period (0,t) = n]

$Pr_{it}(B_{k|n})$ = Pr[# applicants screened in period (0,t) = k| n arrived], k=0,1,...,n

$Pr_{it}[C_k]$ = Pr[$\max_j$ E(prod. of applicant j) < $R_i(t)$ | k screened], j=0,1,...,k [1]

Now, we assume that

$Pr_{it}(A_n) = G_n(t,c,r_i,X_i)$ (i)

$Pr_{it}(B_{k|n}) = H_k(t,X_i)$ (ii)

$Pr_{it}[C_k] = I_k(R_i(t))$ (iii)

where

X_i = vector of characteristics of vacancy i

c = recruitment channel

r_i = region of the firm with vacancy i

I_k = distribution function of the <u>maximum</u> of productivities

In words, the probability that n applicants arrived in the period (0,t) is assumed to be dependent on the elapsed duration, the use of different recruitment channels, the region of the firm and vacancy characteristics. Secondly, the probability that the screening procedure is finished (before time t) for k applicants - given that there are n applicants to consider - is assumed to be dependent on elapsed duration time t and the

[1] $Pr_{it}(B_{0|0})$ and $Pr_{it}(C_0)$ are set equal to 1.

type of vacancy. Finally, the probability that an applicant will not be acceptable is formulated by means of the distribution function of the maximum expected productivity. This probability is dependent on the elapsed duration of the vacancy in two respects (the so-called duration dependence). First, an increasing number of screened applicants over time may lead to a higher probability (over time) that the vacancy is fulfilled. Secondly, employers may find out (in the course of time) that the possibilities to fulfil their jobs are low and react by reducing their reservation productivities, which may also lead to an increasing probability (over time) that the vacancy is fulfilled.

In our empirical application, it is impossible to identify the different components of the fulfilment probability of vacancies, because our data do not contain information on the arrival, screening and selection process. We can only estimate the "reduced form" of (2):

Pr[vacancy duration of job i > t] =

$$\sum_{n=0}^{N} [Pr_{it}(A_n) * \sum_{k=0}^{n} (Pr_{it}(B_{kin}) * Pr_{it}(C_k))] =$$

$$\sum_{n=0}^{N} [G_n(t,c,r_i,X_i) * \sum_{k=0}^{n} (H_k(t,X_i) * I_k(R_i(t)] =$$

$$J_i(t,c,r_i,X_i) \tag{3}$$

where J_i has a certain functional form.

An assumption underlying (3) is that the probability that the "best" applicant (out of k applicants) is acceptable depends on the factors t,c,r_i and X_i.

In the next section, we will demonstrate that it is now possible to write the hazard rate in terms of J_i and hence as a function of time and vacancy characteristics.

3. THE DURATION MODEL.

The vacancy duration can be characterized by the rate at which the vacancies are fulfilled (in general referred to as hazard). If t denotes the duration of a completed spell with density function f and distribution function F, then the hazard is

$$\delta(t) = \frac{f(t)}{1-F(t)} \tag{4}$$

In which the denominator is equal to the probability that the vacancy is not fulfilled at time t (see (2)).

Integrating (4) gives

$$\int_0^t \delta(s)ds = -\ln[1-F(t)] \tag{5}$$

so that

$$f(t) = \delta(t) * \exp[\int_0^t -\delta(s)ds] \qquad (6)$$

which gives a one-to-one correspondence between the distribution of the completed spells and the hazard rate.

If the hazard is assumed to depend on explanatory variables, we can make statistical inferences on the basis of the conditional density function of the completed spell of a vacancy i:

$$f(t|z_i;\beta) \qquad (7)$$

with z_i = vector of explanatory variables
and β = vector of parameters to be estimated

In section 2, we have derived an expression for 1 - F(t) in terms of explanatory variables. Using definition (4), we simply get

$$\delta_i(t) = \frac{-dJ_i(t)/dt}{J_i(t)} = K_i(t,c,r_i,X_i) \qquad (8)$$

This relation will be specified in more detail in our model of vacancy duration.

Now, we will discuss the derivation of the appropriate model for our data on vacancy duration. In case of single-spell duration data on vacancies two general classes of sampling can be distinguished, viz.
- sampling the stock of vacancies
- sampling the flow of vacancies

In the first sampling method, we know the elapsed duration of each vacancy in the sample, whilst in the second sampling method we observe the completed spells of vacancies, which are fulfilled (or do take place) during a certain period.

In this paper, we will use data on vacancy duration sampled among employers under a specific selection rule (i.e. a rule that determines whether or not an observation is included in the sample). The selection rule is that only the most recently fulfilled vacancy in the past six months is observed (if the employer has one or more fulfilled vacancies in that period)[2].

We assume that the stock of vacancies is in a steady state during these six months (and the relevant period before). Then the observed sample is a random sample of vacancies (jobs) flowing out of the stock of vacant jobs during this period[3]. Since in a steady state inflow and outflow are equal (both in size and composition), one may also consider the observed sample as a random sample of jobs flowing into the vacant stock. The steady state assumption implies that the inflow rate of vacancies is constant over time and that the parameters and external conditions governing the outflow of vacancies are constant.

[2] For further details on the data see section 4.1.

[3] Actually, this is an exogeneous stratified random sample with strata being identical to firms: per firm at most one vacancy is sampled.

Thus we arrive at the following conditional likelihood function:

$$L = \prod_i f(t|z_i;\beta) \tag{9}$$

because the conditional density function of the flow into the stock of vacancies coincides with the conditional density function of completed spells of vacancy duration (see Ridder, 1984):

In order to estimate this model, we have to choose a functional form for the hazard function δ introduced in (4). According to the proportional hazard model (introduced by Cox, 1972) δ is specified as:

$$\delta_i(t) = \exp(z_i'\beta) * \tau(t) * v_i \tag{10}$$

with
$\tau(t)$ = a function of elapsed duration t
v_i = an error term
z_i = a vector of vacancy chacacteristics

This specification allows one to test whether the hazard rate is non-constant over time, caused by two effects (see Elbers and Ridder, 1982):
1) the effect of the duration dependence of the probability that the vacancy is fulfilled as a result of an adjustment of the hiring standards made by the employer and changes in the arrival or screening rate of applicants (factor $\tau(t)$);
2) the effect of omitted variables (unobserved heterogeneity), implying a decreasing hazard rate over time, since the jobs with the better unobserved characteristics will first be fulfilled, causing the average hazard rate of the survivors to fall (factor v_i).

This type of model will be referred to as the mixed proportional hazard model (cf. Ridder, 1987). For estimating this kind of model, we have to choose a functional form for the base-line hazard and a distribution function for the error term.

It will be assumed that the base-line hazard $\tau(t)$ has an adjusted[4] Weibull form i.e.

$$\tau(t) = \alpha_0 + \alpha_1 * t^{\alpha_1 - 1} \tag{11}$$

and that v_i follows a Gamma distribution (with mean 1 and variance σ^2).

In order to check whether these choices will not give rise to a misspecified model, we will carry out a number of tests. The specification of duration models has been the focus of various authors in the econometric literature. Lancaster and Nickell (1980), Lancaster (1985) and Ridder and Verbakel (1986) have studied models for the duration of an event that are misspecified by the neglect of random muliplicative heterogeneity in the hazard function. Duration models of the mixed proportional hazard type can take into account the effect of unobserved heterogeneity if an assumption is made on the distribution of the error term. In particular Heckman and Singer (1984) have warned against the dramatic consequences of incorrect assumptions of the distribution of the unobserved heterogeneity. Ridder (1987) shows, however, that in the case of uncensored data the bias of the parameters of the observables is negligible if one has a flexible enough base-line hazard.

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[4] A constant term is added to the Weibull form, because in our sample of fulfilled vacancies some employers have reported that their vacancies are filled immediately (i.e vacancy duration is equal to 0). An additional advantages of this specification is that it makes the base-line hazard more flexible.

The sensitivity of the parameters of interest in the mixed proportional hazard model to the assumptions made on the functional form of the base-line hazard (Weibull) and the distribution of the unobserved heterogeneity (Gamma) will be investigated as follows.

First, it will be tested whether a different (more flexible) specification of the base-line hazard give rise to different estimates for the parameters of the explanatory variables and a different conclusion about the presence of duration dependence.

Secondly, we will check the sensitivity of our model to the distribution of the error term by comparing the parameters of interest on the basis of a Gamma distributed error term with the estimation results of a hazard model with a lognormal distribution of the error term (and assuming a Weibull base-line hazard - including a constant term - in both cases).

Finally, we will compare the resulting pattern of the estimated hazard function with the shape of the sample hazard function.

The outcomes of these specification tests will be presented in section 5.

4. EMPIRICAL RESULTS.

4.1 The data and explanatory variables.

We will apply the duration model developed in section 3 to data on job vacancies in the Netherlands. This data set consists of a sample of 759 vacancies[5]. In the sample, employers were inquired about the characteristics of the vacant job and the firm, their recruitment methods and the period of time between the announcement of a vacant job and the acceptance of an applicant for that job (note that this is not necessarily equal to the total duration of the vacancy: recruitment may start before the job is actual vacant, and it may take time before an applicant who has been accepted actually starts working). The time period between announcement and acceptance will be used as the duration variable in our model of vacancy duration. The information on job and firm characteristics and recruitment methods offers us the possibility to formulate a set of explanatory variables, corresponding to the issues raised in the introduction, i.e., the effect on vacancy duration of:

1) recruitment channels.
2) regional labour market conditions.
3) characteristics of the vacant job and the firm.

The variables related to the effect of the use of **recruitment channels** will be subdivided into two groups. First, employers may search for suitable applicants by using formal channels (advertising, labour exchange office and private employment office). Secondly, informal channels may be used to fill a vacancy (recruitment within the firm and contacting external relations). Informal methods may be faster than formal methods because the employer may have more reliable information about the applicant so that the screening process takes less time. The dummy variables for the kind of recruitment channel are not mutually exclusive: the employer may use more than one recruitment channel in the search process for applicants.

The **condition of the regional/local labour market** will be reflected in the model by either the type of region (classified as urban or rural) or the local unemployment rate[6]. In the first case, we conjecture that in the urban areas vacancies are more easily fulfilled due to the presence of a relatively large number of potential applicants. On the other hand, vacancy durations are likely to be longer in urban areas due to the

[5] In appendix A, the source of the data is discussed in more detail.

[6] In appendix A, the distinction of the Netherlands into urban and rural areas and the division into local labour markets with different unemployment levels are presented.

overrepresentation of new successful sectors (such as the high-tech sector) in these areas (see for example Davelaar and Nijkamp, 1989). Vacancies occuring in new sectors often require highly specialized workers and hence search and selection procedures will take more time. Another reason why vacancy duration may be longer in urban areas is that the composition of labour supply is unfavourable (e.g. because of a high presence of lowly qualified workers). In the second case, we expect that if local unemployment is high, applicants will more easily be found and hence vacancy duration will be shorter.

The **characteristics of the vacant job** can be represented in terms of the required skills of the applicant for that job (educational level, specific educational skills and work experience), the presence of age restrictions for the applicant, and the kind of contract offered to the applicant (permanent versus temporary and full-time versus part-time). The duration of vacant jobs requiring highly educated and experienced workers will probably last longer, because such workers are scarce on the (regional) labour market. In addition, the search and selection (screening, interviewing) procedures for vacancies requiring highly skilled workers do usually take more time than vacancies requiring lower skilled workers.

Finally, we will incorporate **characteristics of the firm** in the analysis of vacancy duration by using variables related to the sector and the size of the firm and the presence of a staff division. For the latter, we expect a positive effect on vacancy duration due to longer administrative procedures in the recruitment process.

Appendix A contains a summary of the data.

4.2 Estimation results.

In this subsection, we will present the maximum likelihood estimates of the proportional hazard model of vacancy duration as specified in section 3. For the estimations, we have used the general maximum likelihood programme GRMAX[7].

In our study, we have estimated two models because the effect of the regional environment on vacancy duration is incorporated at two different aggregation levels, namely the regional level (by means of the distinction between urban and rural areas) and the local level (by means of the local unemployment rate). The estimation results of both models are presented in Table 4.2.1[8].

First, we will consider the model with the effect of the structure of the regional labour market included (model A).

The requirement of a higher educational level has a very significant effect on vacancy duration. This might indicate that highly educated workers are hard to find on the (regional) labour market. It might also be the case that employers use more time in the recruitment procedure for highly educated workers, because the accepted applicant will get an important position in the firm.

The same kind of arguments (shortage of workers and/or differences in recruitment procedures) can be used for the explanation of the positive effect (almost significant at 10%) of requiring specific work experience on vacancy duration.

The use of advertisements as a search method for applicants has (relative to the use of other channels) a large significant positive effect on vacancy duration. Using the labour exchange or the private employment office will lead to much shorter expected vacancy duration than advertising (about twice as small), whilst informal recruitment methods will be almost three times faster than advertising. Therefore, employers who want to shorten the duration of their vacancies should consider search methods other than advertising.

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[7] GRMAX has been written by G. Ridder at the University of Amsterdam.

[8] Note that in Table 4.2.1. the effects of the variables on the hazard rate are presented; the effects on vacancy duration have the opposite sign.

However, the estimation results of the model indicate that using more channels simultaneously will even enlarge vacancy duration. This might be a result of the sequential use of search channels by employers (i.e they decide to use a new (or additional) channel if the first channel did not (yet) lead to a suitable applicant). An alternative explanation might be that the use of different search channels is an endogeneous variable in the model of vacancy duration. If employers expect that the vacancy is hard to fill, they will search for applicants by means of various channels.

It takes considerably more time to fulfil permanent than temporary jobs. This might be due to the fact that employers, who are suddenly confronted with a temporary need for (additional) workers in the firm, have to use adequate and fast recruitment procedures (for example by using private employment offices).

Vacancies in the production sector are much easier to fulfil than vacancies in the industrial and service sector, whilst vacancies in the quarternary sector are most difficult to fulfil. The latter might be caused by the lack of suitable applicants for vacancies in this sector.

We can also observe a longer duration of vacancies in the urban parts of the Netherlands despite the availability of a relatively high number of unemployed people. A large supply of unemployed people is clearly not a quarantee of short vacancy durations. This is an indication of the large qualitative discrepancies of labour demand and supply on the urban labour market.

The function of elapsed duration ($\tau(t)$) has a significant constant term, indicating that some vacancies are fulfilled immediately[9]. The duration dependence parameter α_1 is highly significantly different from 1, which makes the hazard rate rapidly increasing over time. This result may reflect the behaviour of employers, who adjust their hiring standards if vacancies remain unfulfilled for unacceptable long periods[10]. Positive duration dependence has also been found in empirical studies for the Dutch labour market by Van Ours and Ridder (1988) and Van Ours (1989 and 1990). The significant effect of omitted variables (reflected by the variance of the error term) shows that there is unobserved heterogeneity left in the sample leading to a decreasing hazard over time. In sum, the effects of duration dependence and omitted variables on the hazard rate are both present in our model of vacancy duration and exhibit opposite directions of influence. The combination of these effects can be demonstrated by plotting the hazard function (see [7]).

[9] The model with a Weibull base-line hazard is rejected against the model with a constant term included in the base-line hazard on the basis of a LogRatio test (the value of loglikelihood decreases from 1833.0 to 1818.9).

[10] In the context of optimal search behaviour (see section 2), employers may react by reducing their reservation productivity, for example because they adjust their perception of the distribution of productivities in a Bayesian way.

	Model A		Model B	
variable	coeff.	t-value	coeff.	t-value
Constant	0.75	1.69	0.27	0.49
Recruitment channels				
formal:				
- advertisement	-1.58*	-7.50	-1.47*	-6.65
- labour exchange	-0.49*	-3.01	-0.52*	-2.89
- private empl. off.	-0.49*	-3.12	-0.42*	-2.45
informal:				
- external contacts	-0.28	-1.67	-0.45*	-2.31
- internal contacts	-0.14	-0.89	-0.19	-1.08
Regional environment				
- urban area	-0.15	-1.05	x	x
- local u-rate (*10)	x	x	0.15	0.79
Type of job				
Min. required educ.				
- lower vocational	-0.84*	-3.22	-0.94*	-3.47
- secondary general	-1.48*	-5.04	-1.64*	-5.31
- medium vocational	-1.70*	-5.24	-1.86*	-5.33
- high general	-2.72*	-7.46	x	x
Spec. educ. required	-0.01	-0.04	-0.05	-0.23
Experience required				
- specific	-0.36*	-2.02	-0.43*	-2.15
- non-specific	-0.27	-1.15	-0.23	-0.90
Age restrictions	-0.11	-0.73	-0.05	-0.31
Full time job	-0.14	-0.62	-0.02	-0.08
Permanent job	-0.76*	-3.87	-0.65*	-2.99
Type of firm				
Sector				
- industrial	-0.56*	-2.50	-0.71*	-2.85
- services	-0.43*	-1.95	-0.58*	-2.34
- quarternary	-0.78*	-3.05	-1.14*	-3.80
Size of the firm				
- medium	0.14	0.77	0.16	0.82
- large	-0.18	-0.84	-0.14	-0.60
Staff Division	-0.40*	-2.41	-0.36*	-1.96
Time dependence				
α_0	0.88*	2.97	0.97*	2.92
α_1	2.98*	14.13	3.18*	13.72
Variance error term				
σ^2	1.32*	7.11	1.40*	6.99
no. of observations	759		641	
Loglikelihood	1818.9		1448.7	

Table 4.2.1 Estimations results of hazard function for vacancy fulfilmen (* significant at 5%).

Reference groups of the independent variables are given between brackets: regional environment (rural area), minimum required education (primary), required experience (no experience), age restrictions (no restrictions), full time job (part time), permanent job (temporary), sector of the firm (construction), size of the firm (small), staff division (no staff division).

In Figure 4.2.1, the pattern of the hazard function based on the estimation results of model A is shown for a "standard" vacancy[11]. Moreover, it is possible to show the separate effect of duration dependence by plotting the base-line hazard of the abovementioned standard vacancy in the same figure.

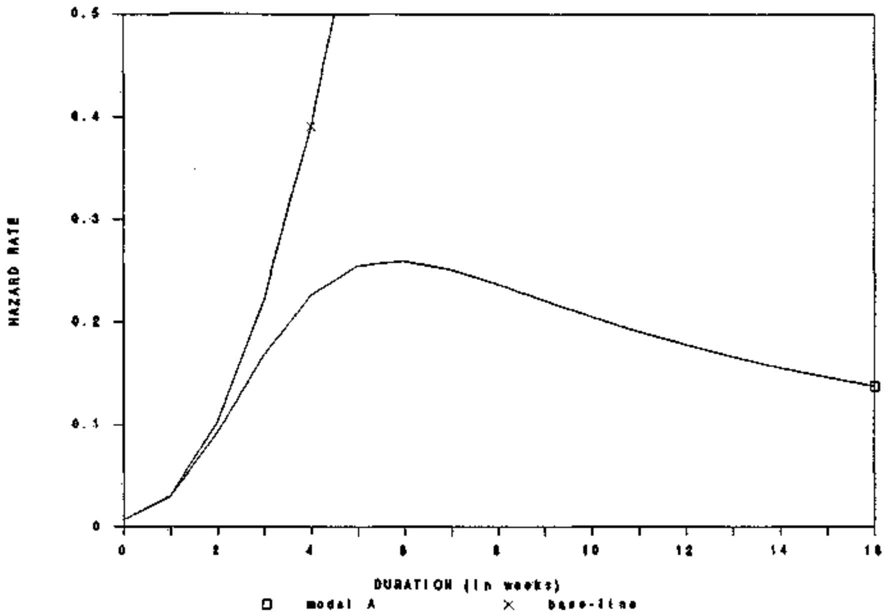

Figure 4.2.1. Hazard function and base-line hazard of the standard vacancy.

The results for model A demonstrate a quite realistic pattern of the fulfilment of vacancies. During the first weeks, the hazard rate of vacancies is increasing rapidly as a result of the positive effect of duration dependence. In the context of the traditional search model (see section 2), this pattern is the result of a decreasing reservation productivity of the employer over time. In the alternative formulation we derived in section 2, positive duration dependence may also stem from an increasing number of (screened) applicants over time. According to this formulation the rapidly increasing hazard rate in the first weeks is due to the fact that recruitment procedures take a few weeks time and usually end with the acceptance of an applicant. The latter explanation is in our opinion much more plausible, because it is unlikely that the employer will reduce his standards in the beginning of the recruitment procedure.

The hazard rate of the standard vacancy reaches its maximum after about one month. After the first month, it becomes more difficult to fulfil the remaining vacancies, as can clearly be seen from the declining hazard rate. Apparently, the effect of omitted variables - making the average hazard rate of the surviving vacancies less than the average hazard of the fulfilled vacancies - does **dominate** the effect of positive duration dependence in the course of time. As a result, the hazard function is decreasing towards 0 over time.

In order to demonstrate the effect of the explanatory variables (for example the required level of education), we will also present the graph of the hazard functions of

[11] The standard vacancy is defined as follows: an employer of a large firm in the services sector (located in an urban area and including a staff division) has a full-time, permanent job to fulfill and is searching by means of an advertisement for an applicant with experience and a medium (vocational) level of education.

the standard vacancy evaluated at different levels of required education (see Figure 4.2.2).

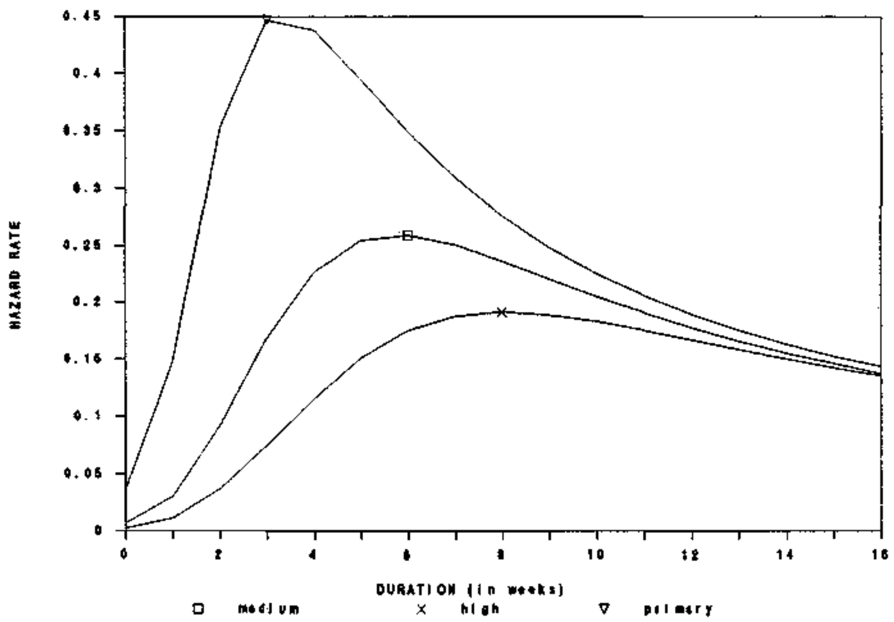

Figure 4.2.2. The effect of requiring different levels of education on the hazard function.

It can be easily seen that the hazard function of vacancies requiring a higher level of education is less steep and has a much lower maximum level (which is also shifted to the right). For example, the maximum level for vacancies requiring the lowest level of education is 0.45 (after 3 weeks), whilst this level for vacancies requiring an academic level is 0.2 (after 8 weeks).

Secondly, we will discuss the estimation results for the model with the local unemployment rate included as an indicator of the tightness of the relevant local labour market (see model B in Table 4.2.1). We recall that the vacancies requiring the highest level of education are left out in this model[12].

The estimation results for the observables are in line with the ones of model A. Furthermore, the effects of duration dependence and omitted variables are similar to the effects in model A, so that the shape of the hazard function is almost identical.

The characteristic feature of model B is the effect of the tightness of the local labour market (Corop regions) on vacancy duration. From Table 4.2.1, it becomes clear that the local unemployment rate has a small negative (insignificant) effect on vacancy duration. The value of the coefficient is of the same magnitude as the estimation result of Van Ours (1988), who has used the regional unemployment rate (measured at the provincial level) as an indicator for the situation on the regional labour market in the Netherlands. The small negative effect of the local unemployment rate on vacancy duration means that local labour market conditions play a minor role in vacancy fulfilment. This result is less pronounced than one would expect on the basis of figures on the distance between the residence of the **accepted** applicant and the location of the firm. Table 4.2.2. shows that about 75% of all jobs are fulfilled by a worker living

[12] Estimating the model on the basis of all vacancies did hardly change the coefficients at the other variables, whilst the coefficient at the local unemployment rate was approximately 0.

within a distance of 15 km.

distance (km)	0-4	5-10	11-15	16-20	21-30	31-50	over 50
percentage of applicants	32%	30%	12%	8%	8%	5%	5%

Table 4.2.2 The geographical distribution of the number of accepted applicants in terms of distance between applicant and firm.

Differences in local unemployment rates are quite high in the Netherlands (even for adjacent regions). For example, the Corop-region[13] of the city Amsterdam has an unemployment rate of about 20% whilst some surrounding Corop regions have unemployment rates of less than 10%. According to our model, this implies that the maximum level of the hazard rate in the surrounding regions is only 0.01 higher (after about six weeks) than in the city Amsterdam.

In conclusion, empirical evidence on the Dutch labour market shows that the **tightness of the local labour market** does only have a minor impact on the duration of vacancies.

5. SPECIFICATION TESTS.

In this section, the hazard rate specification of model A (see section 4.2) will be investigated by means of various tests[14].

The mixed proportional hazard specification of model A leads to estimates for the effects of duration dependence and unobserved heterogeneity, which enables us to identify the causes of a non-constant hazard rate over time. This model, however, uses arbitrary assumptions about the functional form of the base-line hazard and the distribution of the error term (see also section 3). In this respect, Ridder (1987) notes that the identification result of the mixed proportional hazard model is a "mixed blessing", because the identified effects of duration dependence and unobserved heterogeneity may be biased if the functional form of the base-line hazard and/or the distribution of the error term are misspecified.

In order to check the appropriateness of the base-line hazard of model A, we will first estimate a proportional hazard model (model A^*) with an alternative (more flexible) base-line specification of the hazard rate (and assuming a Gamma distributed error term). In model A^* the function of elapsed duration t is formulated as follows:

$$\tau(t) = \alpha_0 + \alpha_1 * t + \alpha_2 * t^2 + \alpha_3 * t^3 + \alpha_4 * t^4 \tag{12}$$

The parameters of model A^* will be estimated by optimizing the likelihood function (see [12]) on the basis of equation [15]. The estimation results can be found in Table 5.1 (column 2).

Although it is difficult to compare the estimates of the observables in model A and A^* directly (because of the different specification of the variation of the hazard rate over time), it can be seen that the effects of the explanatory variables in model A^* point in the same direction as model A. Due to the additional parameters, the overall fit of model A^* is slightly better than model A (see the values of the loglikelihoods in Table 5.1).

The main goal of estimating model A^* is to compare the robustness of the effect of duration dependence. Hence, we will look at the pattern of the base-line hazard of the

13 See Appendix A for the definition of the Corop regions.

14 We will restrict ourselves to model A, because the specification of model B with respect to the base-line hazard and the distribution of the error term is analogous to model A.

standard vacancy for both models (see Figure 5.1). It is remarkable to see that during the first 10 weeks the base-line hazards are almost identical[15]. In the next period (in which less than 10% of our observations of vacancy duration are found), the base-line hazard of model A^* becomes much higher, indicating an even stronger duration dependence (in the long run) than model A.

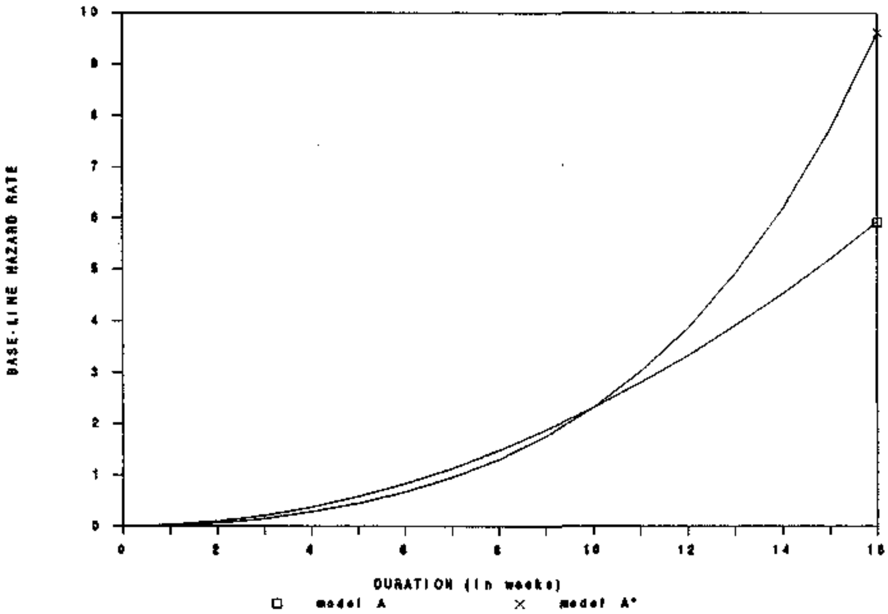

Figure 5.1 Base-line hazards of the standard vacancy for model A and A*.

In sum, the comparison of model A with a different (more flexible) base-line model (incorporating the effect of unobserved heterogeneity) does not give rise to the conclusion that the base-line hazard is misspecified in model A.

Secondly, we will examine the sensitivity of the estimation results for the choice of the distribution function of the error term. This will be carried out by estimating the mixed proportional hazard model (model A) with an alternative (log normal) distribution of the error term. Using this different specification enables us to investigate the robustness of the estimated effects of the explanatory variables, duration dependence and unobserved heterogeneity, respectively on the hazard rate.

The maximum likelihood estimates for the model with a log normal distributed error term (model A^{**}) are obtained by using numerical integration procedures (from the NAG-library) in order to evaluate the loglikelihood (see (9)). The results are presented in Table 5.1 (column 3)[16].

[15] We note that the graphs do not show that the base-line hazards start with a rate different from 0.

[16] We do not present t-values of the alternative models because of the high computational costs of evaluating the information matrix.

variable	Model A coef.	Model A* coef.	Model A** coef.
Constant	0.75	2.49	1.10
Recruitment channels			
formal			
- advertisement	-1.58	-2.70	-1.02
- labour exchange	-0.49	-0.47	-0.45
- others	-0.49	-0.70	-0.49
informal			
- external	-0.28	-0.39	-0.16
- internal	-0.14	-0.11	-0.04
Regional environment			
- urban area	-0.15	-0.02	-0.28
Type of job			
Min. required educ.			
- lower vocational	-0.84	-0.90	-0.75
- secondary general	-1.48	-1.69	-1.34
- medium vocational	-1.70	-2.04	-1.47
- high general	-2.72	-3.20	-2.40
Spec. educ. required	-0.01	-0.21	-0.03
Experience required			
- specific	-0.36	-0.52	-0.21
- non-specific	-0.27	-0.36	-0.21
Age restrictions	-0.11	-0.11	-0.13
Full time job	-0.14	0.02	-0.20
Permanent job	-0.76	-0.69	-0.82
Type of firm			
Sector			
- industrial	-0.56	-0.59	-0.52
- services	-0.43	-0.60	-0.37
- quarternary	-0.78	-0.85	-0.86
Size of the firm			
- medium	0.14	0.34	0.06
- large	-0.18	-0.13	-0.16
Staff Division	-0.40	-0.90	-0.17
Time dependence			
α_0	0.88	-[17]	0.35
α_1	2.98	-	2.31
Variance error term	1.32	1.70	2.97
No. of observations	759	759	759
Loglikelihood	1818.9	1798.1	1847.5

Table 5.1 Estimation results for model A, A* and A**.

[17] In model A*, the function of elapsed duration has the following specification:

$$\tau(t) = \alpha_0 + \alpha_1 * t + \alpha_2 * t^2 + \alpha_3 * t^3 + \alpha_4 * t^4.$$

The estimated coefficients (α's) are [0.84, -2.46, 1.68, -0.07, 0.005], respectively.

From Table 5.1 (column 3) it is easily seen that the estimation results for the explanatory variables of model A^{**} are in line with the result of model A. The effect of duration dependence is less in model A^{**}, whilst the effect of unobserved heterogeneity is more pronounced. The resulting shape of the hazard function is shown in Figure 5.2 for both models.

Although the overall picture of the hazard rate is the same for both models, there are also some differences. The hazard rate of model A reaches a higher maximum and decreased faster afterwards, whilst the hazard rate of model A^{**} is declining modestly after having reached its maximum.

It can be concluded that the maximum likelihood estimates are not too sensitive to the distribution of the error term and that model A (based on a gamma distributed error term) gives a better fit to our data than model A^{**} (based on a log-normal distribution).

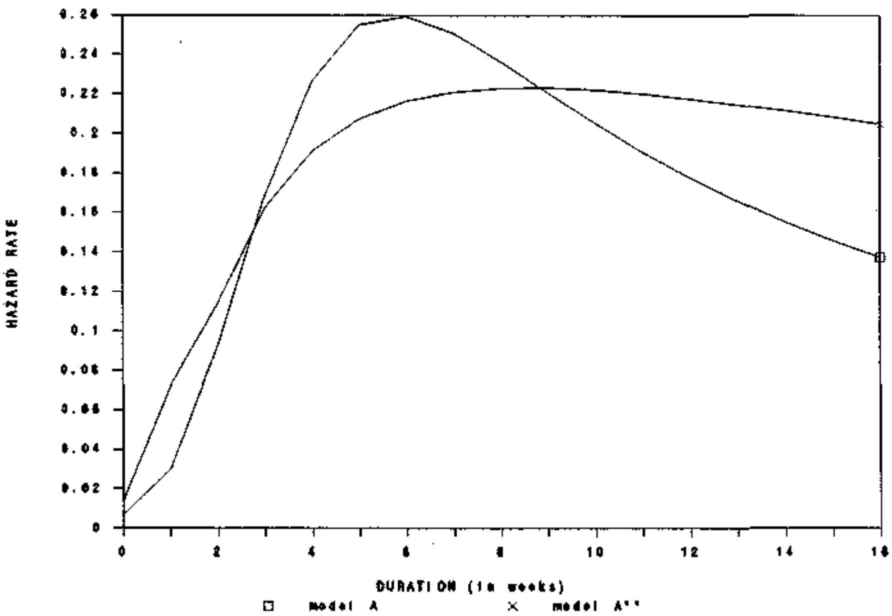

Figure 5.2 Hazard functions of the standard vacancy for model A and A**.

Finally, we want to examine whether the resulting shape of the hazard function (for example of the standard vacancy) is similar to the (smoothed) pattern of the sample hazard function. The sample hazard function is obtained by the well-known Kaplan-Meier estimator:

$$\lambda(t) = \frac{S(t)-S(t-1)}{S(t)}, \quad t=1,2,... \tag{13}$$

with S(t) - the sample survivor function - defined as the relative share of unfulfilled vacancies.

Next, we have smoothed the wildly fluctuating sample hazard function[18] by taken a five-period moving average.

From Figure 5.3 it becomes clear that there is a rather close resemblance between the shape of the sample hazard function and the pattern of the standard vacancy on

[18] A tendency can be observed that people are hired after an even number of weeks.

the basis of model A.

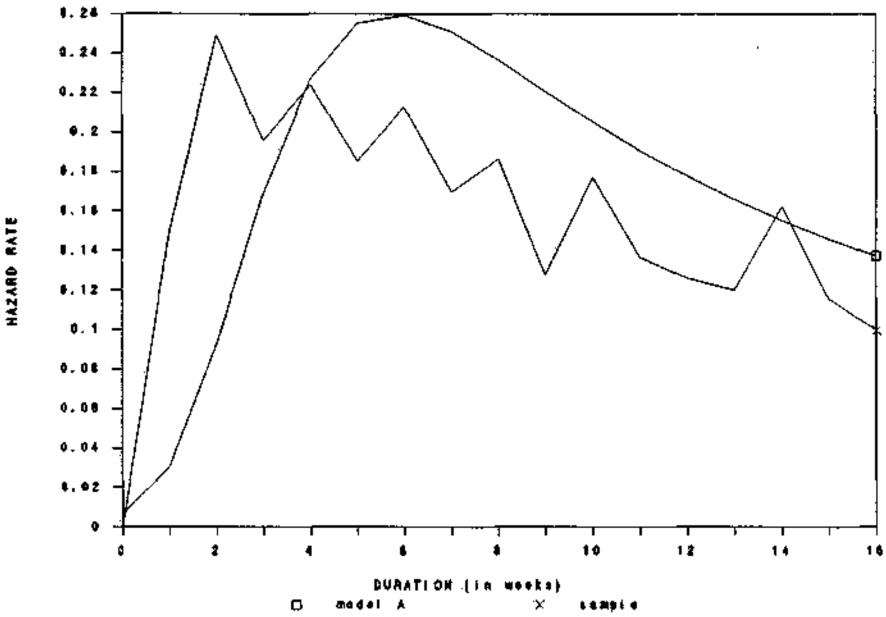

Figure 5.3. Sample hazard function and hazard function model A (standard vacancy).

During the first month, the sample hazard function appears to be slightly higher than the hazard rate of the standard vacancy. This is not surprising because there are vacancies in the sample that are easier to fulfil than the standard vacancy, resulting in a higher hazard rate. In the period after the first month, we observe a reversed pattern.

6. SUMMARY AND CONCLUSIONS.

The aim of this paper was to study the functioning of the Dutch labour market from a demand-side perspective. Regional differences are considered explicitly in the analysis in order to reveal the importance of the geographical concentration of the demand for labour on the Dutch labour market.

In the demand-side oriented approach labour market processes are reflected by the development of the stock of vacancies and the flows entering and leaving this stock. In particular, the intensity at which vacancies are fulfilled (i.e. the outflow rate) can be regarded as an indicator of the tightness of the regional labour market. Therefore, we have examined the determinants of the vacancy outflow rate on regional labour markets in the Netherlands in this paper. In addition, the analysis can be used to identify the possibilities for employers to shorten the duration of their vacancies.

A new theoretical model of employer's search behaviour has been formulated in which the vacancy outflow rate is influenced by

(a) the recruitment procedures of the employer (search, selection and screening respectively);
(b) regional environment;
(c) the type of job (and firm);
(d) elapsed vacancy duration itself.

In order to apply this model empirically, we have derived its reduced form, which could be fitted in a so-called hazard rate approach. We have chosen a mixed proportional hazard rate specification, because this type of model allows us to distinguish between unobserved heterogeneity and duration dependence as explanations of hazard rates that are not constant over time. For the estimation of a mixed proportional hazard model, it is necessary to make an assumption on the functional form of the hazard rate. We have assumed that the base-line hazard has an adjusted Weibull form and the error term follows a Gamma distribution. This model has been tested against misspecification of the base-line hazard by comparing the estimation results with the results from a model with a more flexible functional form. In addition, it is checked whether the results of the mixed proportional hazard model are sensitive to the choice of the distribution of the error term.

The outcomes of the specification tests did not show that the mixed-proportional hazard specification should be rejected. From the estimation results of this model, it can be learned that

(a) the optimal recruitment policy of employers who want to shorten their duration of their vacancies is to start with other search methods than advertising;

(b) vacancy duration is longer in the urban parts of the Netherlands, indicating that there might be a shortage of workers in the urban labour market despite the high level of unemployment;
the tightness of the local labour market (reflected by the unemployment rate) does only have a minor impact on the duration of vacancies which do not require the highest level of education;

(c) the fulfillment of vacancies takes more time if a high educational level and/or specific work experience is required, indicating that there might be shortages of workers with specific qualifications;
vacancy duration is longer for permanent jobs and vacancies in the quaternary sector;

(d) vacancies are positive duration dependent. This effect does not necessarily stem from an adjustment in the hiring standards of employers. It seems more realistic to believe that the positive duration dependence is a result of the changes in the arrival and screening rate of applicants. The pattern of an increasing hazard rate over time is reversed (after about five weeks) by the significant effect of the unobserved heterogeneity.

In sum, studying the determinants of vacancy duration provides useful information on the functioning of regional labour markets. Future structural analysis of the components of employer's recruitment behaviour (search, screening and selection) might lead to a even more comprehensive analysis of the fulfilment of vacant jobs.

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Appendix A.

a) The data source

The data used in our analysis of vacancy duration stem from a survey of the ILBO Institute (Instituut voor Longitudinaal Beleidsonderzoek) carried out in request of the Dutch Ministry of Social Affairs and Employment (the survey was labelled "How do firms recruit"). This survey of employers' recruitment behaviour was undertaken for the first time in December 1984 and has been repeated once a year ever since.

In April/May 1986 a sample of 3198 firms was drawn. Non-response and other reasons (such as firm closures) reduced the sample to 2702 firms. The remaining sample was stratified according to (construction, industrial, service and quaternary) sector and size of the firm (small, medium, large).

From the sample in this survey, firms were selected on the basis of two criteria. First, the firms should have had at least one vacancy which has been fulfilled during the past six months. Secondly, the employer should have searched for applicants by using external channels only or a combination of both internal and external channels.

In this way a subsample of 763 firms - used in this paper - has been selected.

b) Summary indicators of the data in the sample

Dependent variable: vacancy duration

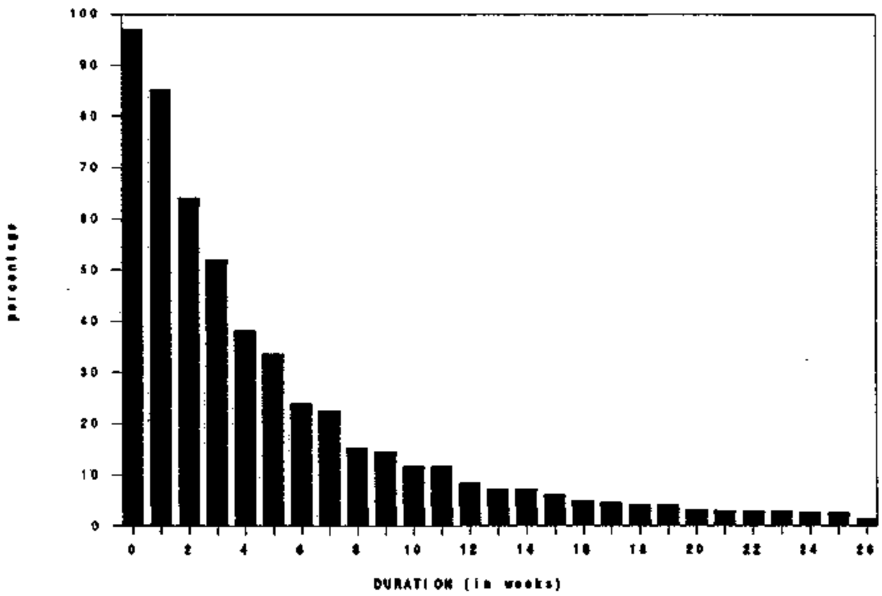


Figure A1. The percentage of fulfilled vacancies in each week.

Explanatory variables:

recruitment channels[19]	number of times used
internal recruitment	236
external relations	191
advertising	419
labour exchange office	206
employment office + others	282
	total: 1334

required characteristics

	yes	no
age requirements	51%	49%

educational requirements	percentage
* primary level	9%
* low vocational level	30%
* secondary level	20%
* extended vocational level	25%
* university/ high vocational level	16%

	yes	no
specific educational requirements	46%	54%

work experience requirements	percentage
* special work experience	58%
* work experience	13%
* no work experience	29%

job and firm characteristics

sector (variant A)	percentage
* construction	20%
* industry	23%
* services	30%
* government	27%

occupational group (variant B)	percentage
* administrative	25%
* technical	23%
* sales	11%
* medical/educational/social	8%
* production	19%
* other	14%

size of the firm	percentage
* small	28%
* medium	39%
* large	33%

location of the firm	percentage
* urban	63%
* rural	37%

	Yes	No
Staff division	45%	55%

	Yes	No
permanent job	84%	16%
full-time job	84%	16%

19 Note that the employer may use more than one recruitment channel at the time.

c) **Regional labour markets in the Netherlands.**

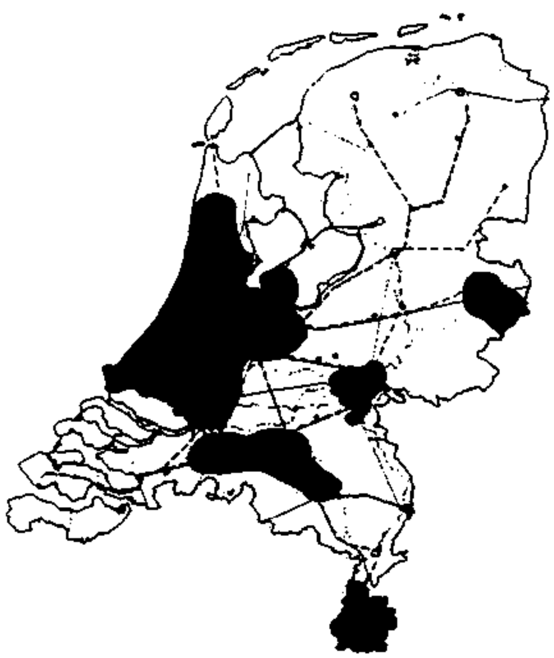
I) Demarcation into 40 Corop-regions:

Legend:

1 Oost-Groningen
2 Delfzijl
3 Overig Groningen
4 Noord-Friesland
5 Zuid-West-Friesland
6 Zuidoost-Friesland
7 Noord-Drenthe
8 Zuidoost-Drenthe
9 Zuidwest-Drenthe
10 Noord-Overijssel
11 Zuidwest-Overijssel
12 Twente
13 Veluwe
14 Achterhoek
15 Arnhem en Nijmegen
16 Zuidwest-Gelderland
17 Utrecht
18 Kop van Noord-Holland
19 Alkmaar
20 IJmond
21 Haarlem
22 Zaanstreek
23 Groot-Amsterdam
24 Het Gooi en Vechtstreek
25 Leiden en Bollenstreek
26 's Gravenhage
27 Delft en Westland
28 Oost Zuid-Holland
29 Groot Rijnmond
30 Zuidoost Zuid-Holland
31 Zeeuwsch-Vlaanderen
32 Overig Zeeland
33 West Noord-Brabant
34 Midden Noord-Brabant
35 Noordoost Noord-Brabant
36 Zuidoost Noord-Brabant
37 Noord-Limburg
38 Midden-Limburg
39 Zuid-Limburg
40 Zuidelijke IJsselmeerpolders
23A Amsterdam
29A Rijnmond / 35A Den Bosch

Map 1. Corop-regions in the Netherlands.

II) Demarcation into urban and rural areas:



Legend:

■ = urban areas

□ = rural areas

Map 2 Urban and rural areas in the Netherlands.

1988-1	H. Visser	Austrian thinking on international economics
1988-2	A.H.Q.M. Merkies T. van der Meer	Theoretical foundations for the 3-C model
1988-3	H.J. Bierens J. Hartog	Nonlinear regression with discrete explanatory variables, with an application to the earnings function
1988-4	N.M. van Dijk	On Jackson's product form with 'jump-over' blocking
1988-5	N.M. van Dijk M. Rumsewicz	Networks of queues with service anticipating routing
1988-6	H. Linneman C.P. van Beers	Commodity Composition of Trade in Manufactures and South-South Trade Potential
1988-7	N.M. van Dijk	A LCFS finite buffer model with batch input and non-exponential sevices
1988-8	J.C.W. van Ommeren	Simple approximations for the batch-arrival $M^X/G/1$ queue
1988-9	H.C. Tijms	Algorithms and approximations for bath-arrival queues
1988-10	J.P. de Groot H. Clemens	Export Agriculture and Labour Market in Nicaragua
1988-11	H. Verbruggen J. Wuijts	Patterns of South-South trade in manufactures
1988-12	H.C. Tijms J.C.W. van Ommeren	Asymptotic analysis for buffer behaviour in communication systems
1988-13	N.M. van Dijk E. Smeitink	A non-exponential queueing system with batch servicing
1988-14	J. Rouwendal	Existence and uniqueness of stochastic price equilibria in heterogeneous markets
1988-15	H. Verbruggen	GSTP, the structure of protection and South-South trade in manufactures
1988-16	Mevr. H. Weijland Mevr. R. Herweijer J. de Groot	Female participation in agriculture in the Dominican Republic
1988-17	N.M. van Dijk	Product Forms for Random Access Schemes
1988-18	A.H.Q.M. Merkies I.J. Steyn	Adaptive Forecasting with Hyperfilters
1988-19	J. Rouwendal	Specification and Estimation of a Logit Model for Housing Choice in the Netherlands
1988-20	J.C.W. van Ommeren R.D. Nobel	An elementary proof of a basic result for the GI/G/1 queue
1988-21	H. Kool	A Note on Consistent Estimation of Heteroskedastic and Autocorrelated Covariance Matrices
1988-22	C.P.J. Burger	Risk Aversion and the Family Farm
1988-23	N. van Dijk I.F. Akyildiz	Networks with mixed processor sharing parallel queues and common pools
1988-24	D.J.F. Kamann P. Nijkamp	Technogenesis: Incubation and Diffusion
1988-25	P. Nijkamp L. van Wissen A. Rima	A Household Life Cycle Model For the Housing Market
1988-26	P. Nijkamp M. Sonis	Qualitative Impact Analysis For Dynamic Spatial Systems
1988-27	R. Janssen P. Nijkamp	Interactive Multicriteria Decision Support For Environmental Management
1988-28	J. Rouwendal	Stochastic Market Equilibria With Rationing and Limited Price Flexibility
1988-29	P. Nijkamp A. Reggiani	Theory of Chaos in a Space-Time Perspective
1988-30	P. Nijkamp J. Poot J. Rouwendal	R & D Policy in Space and Time
1988-31	P. Nijkamp F. Soeteman	Dynamics in Land Use Patterns Socio-Economic and Environmental Aspects of the Second Agricultural Land Use Revolution
1988-32	J. Rouwendal P. Nijkamp	Endogenous Production of R & D and Stable Economic Development
1988-33	J.A. Hartog E. Hinloopen P. Nijkamp	Multicriteria Methoden: Een gevoeligheidsanalyse aan de hand van de vestigingsplaatsproblematiek van kerncentrales
1988-34	R. van der Mark P. Nijkamp	The Development Potential of High Tech Forms in Backward Areas - A Case study for the Northern Part of The Netherlands
1988-35	E.R.K. Spoor J.W.B. Vermeulen	Principes en gebruik van Envisage
1988-36	C. Gorter P. Nijkamp P. Rietveld	The Duration of Unemployment: Stocks and Flows on Regional Labour Markets in the Netherlands
1988-37	M. Hofkes	Parametrization of simplicial algorithms with an application to an empirical general equilibrium model
1988-38	J. van Daal A.H.Q.M. Merkies	A Note on the Quadratic Expenditure Model