# Unemployment Duration and Heterogenous Search Behavior among Swedish Disabled Workers*

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**Abstract**

Return to employment, after a period of unemployment, is analyzed for a large sample of Swedish occupationally disabled workers. A piece-wise constant model is used, extended to allow for Gamma heterogeneity. Three competing exits from unemployment are accounted for; regular employment, sheltered/subsidized employment and withdrawal from the labor force. The model is also generalized by accounting for differing search behavior within the population.

The hazard rate is constant or slightly increasing over time, for exit to some kind of employment. However, for exit from unemployment by leaving the labor force, the hazard shows quite strong positive duration dependence. Men tend to be more probable to leave unemployment for regular employment, and less probable than women to leave the labor force. The probability of finding regular employment is smallest for workers with psychological disabilities, while high-school or university education as well as previous professional experience increases the hazard rate for regular employment.

The heterogeneity due to differing search behavior appears to be at least as important as the Gamma heterogeneity. The estimated probabilities of no search for one particular exit varies, across exits and subsamples, between 0.0 and 0.4.

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# 1 Introduction

There are multiple roles for Swedish Labour market policy. First, a stabilizing role, to provide employment and financial assistance in a contra cyclic way. Second, an active policy aims at increasing the efficiency on the labour market, providing a labour force with adequate skills. Third, there is a distributional role which means policies directed to individuals with a weak position on the labour market, aiming at achieving a more even income distribution.

Among the priority groups having the weakest positions on the labour market are, for example, immigrants, individuals with little or no education, and the occupationally disabled or occupationally handicapped. The latter group is the focus of this paper. According to the definitions of the World Health Organization (WHO)[1] "a handicap is a disadvantage resulting from an impairment or disability". This means that regarding an individual's working life, an impairment may be a handicap for one kind of profession, but not for others. Further, the prejudicial attitudes toward individuals with impairments, may make an individual handicapped by limiting his opportunities on the labour market. The policy used by the Swedish employment offices coincides with the definition of WHO; an impairment which (negatively) influences the individual's professional life is considered a "disability", and the same definition will be used throughout this paper.

In Sweden about 700,000 individuals aged 16 to 64 years are considered occupationally disabled (1996), corresponding to about 12 percent of the working population.[2] The non-disabled working population are employed to 75 percent, while the corresponding figure for the disabled working population is only 48 percent. The disabled have been overrepresented in the registers of unemployed for a long time. This means that during the recession of the 90's, the increase in registration for the disabled has been smaller (plus 70 percent) than for the non-disabled (plus 250 percent).

Some of the disabled are given disability pension, often after a longer period on the sick-list. The number of new early (or disability) retirements has been about 40,000-50,000 individuals every year since 1980, with quite large fluctuations. A peak was reached in 1993 when about 60,000 were given early retirement, and of which 37,000 were aged 40-59 years. Earlier, it was possible to grant an individual

[1] See e.g. Baldwin and Johnson (1993).

[2] All figures given here are found in official statistics from the National Labour Market Board in Sweden (available in Swedish only).

early retirement, motivated only by his poor opportunities on the labour market. This possibility was removed by law in 1991, though it says that it may still be in use in practice.

According to the figures given above, the labour market situation is troublesome for disabled workers. The disabled workers have also since many years been an important priority group for active labor market policy in Sweden. However, it is also a fact that when evaluating Swedish policy programs, the handling of the disabled has usually been rudimentary. In Carling et al. (1996)[3] all disabled individuals were excluded from a large dataset of Swedish unemployed, probably because the disabled are suspected to differ from non-disabled unemployed, in many and important respects. With a simple dummy variable technique it has been found, for example, that the disabled workers make in practice a priority group for labor market training and that disabled participants also gain considerably from such a program (Brännäs and Eriksson, 1996). However, the special conditions facing disabled workers ought to be given some attention.

I will analyze unemployment duration for a large sample of Swedish disabled workers, in which everyone registered at a local employment office during 1992. The analysis will not include any disabled who manage without the service of an employment office. Neither will I include disabled workers who had withdrawn from the labour market (due to retirement, etc.) before 1992. I am interested in unemployment duration among the disabled workers and the duration ends when the workers leave unemployment.[4] I will allow for three unique exits from unemployment; regular employment, sheltered or subsidized employment, and finally, withdrawal from the labor force. For non-disabled workers the exit to subsidized/sheltered employment is not of importance, while we shall see that 20 percent of the disabled leave unemployment this way.

The occupationally disabled form a very heterogenous group, maybe an even more heterogenous group than the non-disabled. An occupationally disabled worker may mean anyone from a skilled person in a wheel chair, competing for high skill jobs, to a person with severe disabilities, who will never be able to find regular em-

[3] This paper will serve as an important reference, since it analyzes Swedish non-disabled unemployed workers, who were registered as unemployed at about the same time as the disabled unemployed of this paper. One important difference between the papers is that Carling et al. include individuals aged 16-55, while the present paper will set the lower age limit at 25 years.

[4] I will assume that "unemployment" means "time as registered at a local employment office". An unemployed individual may be openly unemployed or participate in policy programs. Se further section 2.3.

ployment, but is directed to e.g. sheltered employment. I will use a model allowing for differing search behavior across individuals, in order to take into consideration this heterogeneity among the disabled.

A few important aspects of unemployment durations are discussed in section 2; duration dependence, individual heterogeneity, infinite durations, and policy program participation during unemployment. The dataset to be analyzed will be described in section 3. In section 4 the econometric model to be used is presented. Empirical results follow in section 5 with concluding remarks in section 6.

# 2 Unemployment duration

## 2.1 Escape from unemployment and duration dependence

A variable of vital interest to an unemployed worker is the time spent as unemployed, i.e. the unemployment duration. Besides that unemployment may mean lower income during the spell itself, it may also affect future labor market prospects negatively (see e.g. Edin and Holmlund, 1991, Heckman and Borjas, 1980). The risk (or chance, rather) of leaving unemployment is often described by the hazard rate, which is the probability of leaving unemployment in the next infinitesimal period, conditional on the individual is still unemployed.

Whenever the hazard is not constant over time, there is duration dependence. Positive duration dependence means that the hazard increases by time, while with negative duration dependence the hazard decreases over time. Some argue that the probability of leaving unemployment decreases with the length of the spell (e.g. Lancaster, 1990) but others claim the opposite. Carling et al. (1996) and Hui (1991) for example, show that the escape rate from unemployment increases, as the exhaustion time of benefits is getting closer. This phenomenon can be addressed to two effects; the search activities of the unemployed increases and his reservation wage decreases. Thus, the formation of the benefit system, like the Swedish with fixed duration of benefits, can actually induce this observed duration dependence.

Considering the hazard rate of disabled unemployed workers, where the hazard reflects escape *from* unemployment and *to* employment, the shape of the hazard will depend on how we define "employment". First, if "employment" is defined as employment on the regular labor market only, we expect duration dependence to be negative. That is, individuals who can find a regular job is expected to do this rather quickly. The probability of finding such a job then decreases with the length of the unemployment spell, due to depreciation of knowledge and work experience, due to stigma caused by unemployment or due to "passivity" and thereby a lower search intensity. Regular employment may mean both recall to a former employer and employment with a new employer.[5] According to several studies (see e.g. Han and Hausman, 1990, and their references) it is wise to treat recalls to former employer and new jobs separately, however in this study, recalls will be treated as other regular employment.[6]

Some disabled unemployed may not be able to find regular employment in the nearest future, due to the severity of their disability. This group of unemployed may have to rely on employment aimed in particular (but not exclusively) at disabled, such as sheltered employment and employment with wage subsidies. For leaving unemployment to this kind of subsidized/sheltered employment, a positive duration dependence is expected. The longer the unemployment spell, the more efforts are probably made by the unemployed and/or the official at the employment office, to find some kind of employment if regular employment is not an available option.

Finally, the unemployed can leave unemployment by withdrawing from the labour force through early retirement, by finding education outside the domain of the employment offices, etc. To leave unemployment in this way is also expected to show positive duration dependence, due to efforts of the employment officer as time in unemployment spell is increasing, or due to the decision to retire, as other opportunities have failed. From the data to be used in the empirical application, we will unfortunately not have information on whether each individual's withdrawal from the labor force is permanent (e.g. retirement) or temporary (e.g. university studies).

In the empirical application, three excluding exits will be accounted for; regular employment, sheltered or subsidized employment, and withdrawal from the labor force. To allow for full flexibility and non-monotonicity of the hazard rate, a piecewise constant specification will be used (see further section 4).

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[5] According to a Swedish study by Harkman and Jansson (1995), in a sample of non-disabled unemployed, as many as 45 percent of a who found employment in 1994, were re-employed by a former employer. The authors assume that the recalls is one important explanation to low search intensity among Swedish unemployed, compared to unemployed in other European countries.

[6] According to informal information from the National Labour Market Board, recalls are highly under-reported in the database to be used, and do not serve to reflect true recalls.

## 2.2 Heterogeneity and allowing for infinite durations

Unobserved heterogeneity among individuals is always present when not all characteristics of importance can be observed (by the observer). Heterogeneity may be even more important for disabled unemployed, than for non-disabled. Most important, the impairment caused by a disability is unobservable to us, and to some extent unobservable also to potential employers. The impairment caused by a specific disability is difficult to foretell, which may be one explanation to why disabled are discriminated on the labor market (see e.g. Baldwin and Johnson, 1993). Not controlling for heterogeneity when modelling duration will lead to biased inference of the duration dependence (see e.g. Lancaster, 1990).

For duration analysis allowing for heterogeneity, a so called mixture model is the most common tool. According to Lancaster (1990, Ch. 4) there are three explanations for the emergence of a so called mixture models allowing for heterogeneity; error in recorded durations, error in recorded regressors and, finally, the common explanation of omitted variables. In the data to be used here, there are probably some errors in recorded durations.[7] However, unobservable and therefore omitted regressors is probably the most important source of heterogeneity. Many characteristics of the unemployed which are unobservable to us, the degree of the disability, ambition, motivation, etc., are important factors for the unemployed's opportunities on the labour market. According to Lancaster (1979) we may also interpret heterogeneity as that individuals search for en exit from unemployment under uncertainty, and individuals are unequally lucky in their search.

Another way to allow for heterogeneity is to assume that the search behavior differs across individuals. Some disabled individuals are unemployed for the same reasons as any non-disabled individual with similar qualifications. They will be between jobs for some time, while searching for regular employment and nothing else. On the other hand, some disabled individuals have severe disabilities and will never be able to get regular employment, why this alternative is not even searched for. Instead, subsidized/sheltered employment or the like may be a more realistic option for escaping unemployment.

If there is a positive probability that a particular exit route is not relevant to every individual in the population, there is a positive probability that latent du-

[7] For example, an unemployed who gets a regular job may wait a few days until he informs the employment official. At recording the job in the database, the official may use the date when he got the information, and not the true date which is a week earlier. For modelling of errors in durations, see Brännäs (1996).

rations (i.e. latent due to censoring) may be infinite, rather than drawn from a conventional distribution. This "defective risk problem" can be thought of as a multi-sector search model, in which some individuals never search in certain sectors. Pudney and Thomas (1995) model two competing exit routes from unemployment; re-employment in former industrial sector and employment in a different industrial sector, where the two categories are addressed as sectorial "stayers" and "movers", respectively. By accounting for that not everyone in their sample chooses freely between "staying" and "moving", Pudney and Thomas introduce a model where actual search may be limited to only one of the two sectors.

In the empirical analysis I will account for two kinds of heterogeneity; the kind of heterogeneity assumed in a so called mixture model and heterogeneity in the form of differences in search behavior.

## 2.3 Participation in policy programs during unemployment

In most studies on unemployment duration among Swedish workers the term "unemployed" has been used in the meaning of "openly unemployed" and participation in a policy program (training, relief work, etc.) has been treated as an *exit* from unemployment. This definition is made in for example Carling et al. (1996), Edin (1989) and Edin and Holmlund (1991). However, in this study I will assume that *unemployment* is the sum of time spent in open unemployment and time spent in policy programs and I will explain the reason for this assumption below.

Lately in Sweden, a keen interest has been shown in the situation of the long-term unemployed. In late 1998 a project was initiated by the Ministry of Labour, focused exclusively on "long-term registered unemployed", meaning workers registered at employment offices for two years or more. In these two years, both time as open unemployed and time spent in policy programs are included. In 1998 there were close to 100,000 long-term unemployed, according to this definition. This group has grown fast during the recession of the 90's, and while the unemployment rate is now falling, the group of long-term unemployed is still growing. The Ministry concludes that very few in this group appear to find regular employment, but tend to be in a vicious circle of policy programs and open unemployment, far from the regular labor market. The aim of the project is to make a survey of the long-term unemployed and to determine the factors leading to these very long unemployment spells. We shall see that in the sample of disabled to be used in this paper, as many as 25 percent are long-term unemployed according to the definition of the Ministry of Labour. Thus, when analyzing long-term unemployment, the difficult labor market situation of the disabled is one contributor to the observed problem.

The Government concern described above partly stems from the fact that there is reason to believe that *total* time in unemployment and not just time in *open* unemployment, will influence future labor market prospects of unemployed. A long period of unemployment may be stigmatizing even if some part of it is spent in active policy programs. Total time in unemployment will also have an impact on the human capital decay, the work experience, the lifetime income profile, etc., even though policy programs aim at decreasing these negative consequences of unemployment.

When assuming that unemployment duration includes time spent in active policy programs, the individuals to be analyzed will differ in their policy program history when leaving unemployment. Modelling selection into (and also out of) policy programs in duration models, is a very complicated task (see Gritz, 1993, Ham and LaLonde, 1996). I will here avoid the selection matter by dividing the sample by policy program history, and estimate the model for more homogenous subsamples separately.

# 3 Data

The sample to be analyzed in this paper consists of disabled workers who registered at a local employment office during 1992. I have limited the analysis to include workers between 25 and 55 years of age. By these exceptions the sample to be used consists of 32,609 individuals[8] and I will analyze their first unemployment spell starting in 1992. This first unemployment spell ended when the individual was deactivated from the register of unemployed. Reasons for deactivation is some kind of employment, retirement or that the individual looses contact with the employment office for some other (known or unknown) reason. The data runs until January 1996 which means that everyone not deactivated at that time will be treated as a censored observation. Only the first unemployment spell will be analyzed. i.e. if a worker gets a job and then returns as unemployed after a while, the second spell is not included in the analysis.

[8] The younger group is excluded in order to avoid unemployed who have not yet established themselves on the labour market, and the older group to avoid early retirements quite close to the time of regular retirements. Individuals outside the age interval and those who lacked important pieces of data or had contradictory labour market histories, have been excluded from the original sample of about 70,000 individuals.

Table I: Statistical mean of individual characteristics, by handicap. All descriptive statistics refer to characteristics of the individuals at onset of unemployment spell (1992).

| Variable and its mean, by disability | Physical | Other | Total |
|---|---|---|---|
| Male (=1) | 0.52 | 0.72 | 0.59 |
| Age | 39.04 | 36.76 | 38.28 |
| Entitled to unemployment insurance (=1) | 0.60 | 0.30 | 0.50 |
| Entitled to cash assistance (=1) | 0.05 | 0.05 | 0.05 |
| Nordic citizen, not Swedish (=1) | 0.03 | 0.05 | 0.04 |
| Foreign citizen, not Nordic (=1) | 0.07 | 0.05 | 0.06 |
| High school education (=1) | 0.41 | 0.26 | 0.36 |
| University education (=1) | 0.05 | 0.03 | 0.04 |
| Some experience in profession (=1) | 0.21 | 0.25 | 0.22 |
| Long experience in profession (=1) | 0.39 | 0.24 | 0.34 |
| Unemployment rate | 4.85 | 4.74 | 4.81 |
| "Disability rate" | 21.44 | 20.40 | 21.09 |
| "Program rate" | 10.89 | 10.25 | 10.68 |
| $n$ | 21,789 | 10,820 | 32,609 |

Descriptive statistics are presented in Table I, for those with a physical and a non-physical disability, respectively. About two thirds have a physical disability, and the remaining third other than physical disability.[9] I will also include three variables at the municipal level, in order to take into account local labor market variation. These variables are *unemployment rate* (openly unemployed), *"disability rate"* (openly unemployed with a disability) and *"program rate"* (total number of unemployed who enter policy programs). The *unemployment rate* is the number of unemployed in relation to the local population aged 16-64, while the other rates are in relation to open unemployment. All figures are means across months in 1992 and expressed in percentages.

The *unemployment rate* is expected to have a negative impact on the probability to leave unemployment. The *disability rate* measures "competition" between disabled at the local labor market. A high disability rate may either increase unemployment duration (since more disabled workers compete for regular and subsidized/sheltered jobs) or decrease duration (since more disabled unemployed withdraw from the labor force due to poor opportunities, the so called discouragement

[9] It should be noted that each worker can have only one code for disability in the register, even if he is in reality multi-handicapped.

effect). Finally, the *program rate* should mean shorter unemployment spells, provided that policy programs have the desired effect of leading to better matching of the unemployed to existing jobs. On the other hand if the local employment offices tend to offer policy programs as substitutes for regular or subsidized/sheltered employment, a high program rate may mean delayed exit from unemployment.

Table II: Shares with different length of unemployment spells, with mean length of spells. For new entrants into unemployment in 1992.

| Length of unemployment spells, by disability | Physical | Other | Total |
|---|---|---|---|
| $>$ 90 days | 0.862 | 0.749 | 0.824 |
| $>$ 180 days | 0.739 | 0.569 | 0.682 |
| $>$ 365 days | 0.542 | 0.342 | 0.475 |
| $>$ 420 days | 0.492 | 0.301 | 0.429 |
| $>$ 730 dagar | 0.306 | 0.151 | 0.254 |
| Censored spells | 0.151 | 0.057 | 0.120 |
| Mean, including censored spells* ($n = 32,609$) | 545 | 357 | 483 |
| Mean, excluding censored spells ($n = 28,708$) | 410 | 300 | 371 |

* For the censored cases the number of days until the date of censoring has been used, meaning a maximum of 1,492 days.

In Table II some descriptive statistics of unemployment spells are presented. As many as 68 percent in our sample are unemployed for more than six months.[10] Nearly half of the sample are unemployed for more than a year. After 420 calendar days the unemployment insurance benefits expire, for those who are eligible.[11] About 25 percent of the sample are long-term unemployed according to the Government definition mentioned earlier; a total time as registered exceeding two years.

There were ten different policy programs the unemployed may have been in during their unemployment spell. A very important source of heterogeneity among the unemployed of our sample, is their differences in policy program participation during the unemployment spell. To avoid the complicated endogeneity problem of program participation when exit from unemployment is analyzed, the sample will be divided by program participation history. We divide the sample into four subsamples, in which the workers have participated in *(A) zero programs*, *(B) only vocational rehabilitation*, *(C) one program other than vocational rehabilitation*, and

[10] This is the definition of long term unemployment, as stated by the National Labour Market Board, if the worker is 25 years or older (which holds for everyone in our sample).

[11] Participation in some policy programs, for example labor market training, ensures the participant a new period of benefits, if participation exceeds six months.

*(D) two or more programs*, respectively. Table III presents shares with different policy program histories. We observe that workers with physical disabilities tend to participate in more programs, than do workers with psychological disabilities.

Table III: Subsamples with different policy program histories. Estimations will be made for the four subsamples separately.

| History | Physical | Other | Total |
|---|---|---|---|
| A. No program | 0.439 | 0.575 | 0.484 |
| B. Only vocational rehabilitation | 0.154 | 0.131 | 0.146 |
| C. One program other than rehabilitation | 0.192 | 0.177 | 0.187 |
| D. Two or more programs | 0.215 | 0.117 | 0.183 |
| Total | 1.000 | 1.000 | 1.000 |
| $n$ | 21,789 | 10,820 | 32,609 |

In Table IV we summarize how the unemployment spells end. About 14 percent of our sample found regular employment while 20 percent were deactivated for subsidized or sheltered employment meant particularly (but not exclusively) for disabled workers.[12] As many as 41 percent withdrew from the labour force (i.e. education outside the employment office, retirement and other known reasons) while 24 percent are censored (including those who lost contact with the employment office for unknown reason). Finally, in Table V we summarize exits by the workers program histories.

Table IV: Reasons for deactivation of an unemployed, i.e. reasons for ending an unemployment spell.

| Reason for end of spell, by disability | Physical | Other | Total |
|---|---|---|---|
| Regular employment, including recalls | 0.173 | 0.082 | 0.142 |
| Sheltered/subsidized employment | 0.197 | 0.214 | 0.203 |
| Non-particpation in labor force | 0.384 | 0.462 | 0.410 |
| Censored including lost contact | 0.246 | 0.242 | 0.245 |
| Total | 1.000 | 1.000 | 1.000 |
| $n$ | 21,789 | 10,820 | 32,609 |

[12] These are, with their respective size in our sample in parenthesis, wage subsidy (14 percent), sheltered employment at *Samhall* (3.7 percent) and public sheltered employment (2.6 percent).

# 4 Econometric issues

Pudney and Thomas (1995) present a competing risks (CR) model allowing for two important departures from the simplest modelling; unobserved heterogeneity among individuals and the existence of infinite expected durations. I will extend the model proposed by Pudney and Thomas, in which I will assume three unique exits from unemployment; *regular employment including recall*, *sheltered/subsidized employment* and *non-participation including retirement.*[13] The original model is extended to a piecewise constant specification of the base-line hazard, in which I also allow for unobserved Gamma heterogeneity.

## 4.1 Hazard functions

The risk (or chance rather) of leaving unemployment can be described by the hazard rate, $h(t|x;\theta)$, which is the probability of leaving unemployment in the next infinitesimal period, conditional on that the individual is still unemployed, i.e.

$$h(t|x;\theta) = \lim_{\Delta \to 0} \frac{\Pr(t \leq T < t+\Delta | T \geq t)}{\Delta} = \frac{f(t|x;\theta)}{1-F(t|x;\theta)} = \frac{f(t|x;\theta)}{S(t|x;\theta)}. \tag{1}$$

Here, $f(t|x;\theta)$ is the density function of $t$ and $S(t|x;\theta)$ is the survivor function, i.e. the probability that the unemployment spell will last until at least $t$, while $x$ is a vector of individual specific characteristics and $\theta$ is a parameter vector. With $q$ different risks, or exit routes, and $t_j$ the time until occurrence of the $j$:th risk, the observed duration is

$$t = \min(t_1, ..., t_q)$$

and the observed exit $r$ is

$$r = \arg\min\{t_j\}, \ j = 1, ..., q.$$

For a moment, let us restrict the exposition to one exit only. If we suppress the conditioning on $x$ and $\theta$, and denote the hazard rate with $h(t)$, the survivor function can be expressed as

$$S(t) = 1 - F(t) = \exp(-\Lambda(t)). \tag{2}$$

[13] Unfortunately there is no code specifically for deactivation due to retirement (i.e. early or disability retirement). Disability retirement and unemployment as possible substitutes is discussed and modelled for the case of Germany in Riphahn (1997).

where $\Lambda(t)$ is the integrated hazard function

$$\Lambda(t) = \int_0^t h(s)ds. \tag{3}$$

This means that we may express the hazard rate as

$$h(t) = -\frac{d \ln S(t)}{dt}.$$

Let us represent the hazard rate by two components, as

$$h(t|x) = h_0(t)\lambda(x) \tag{4}$$

where $h_0(t)$ is the so called base-line hazard, while $\lambda(x)$ is an individual specific component. Pudney and Thomas (1995) start by assuming a so called Weibull hazard function in which the base-line is either constant over time, monotonically increasing or monotonically decreasing over time. The authors conclude that the assumed monotonicity is too simple to capture their data and pass onto a two-regime specification with constant base-line within the two intervals.[14] For the individual-specific part of the hazard I will use the most common specification; $\lambda(x) = \exp(x\beta)$. To allow for full flexibility of the base-line, I will use a piece-wise constant (PC) hazard model (see e.g. Lancaster, 1990). This means that for the base-line hazard the time axis is divided into $M$ intervals;

$$h_0(t) = \begin{cases} \theta_1 & \text{if} \quad 0 \leq t \leq c_1 \\ \theta_2 & \text{if} \quad c_1 < t \leq c_2 \\ \vdots & \vdots \quad \vdots \\ \theta_M & \text{if} \quad c_{M-1} < t < \infty \end{cases} \tag{5}$$

where $\theta_k$ are constants while $c_k$ are define points in time, and $0 < c_1 < c_2 < ... < c_{M-1} < \infty$. A convenient specification is to use $\theta_k = \exp(\gamma_k)$ which means that the hazard may be written as

$$h(t|x) = \lambda(x)\exp(d_k\gamma_k) = \exp(x\beta + d_k\gamma_k) \tag{6}$$

where the dummy variable $d_k = 1$ if duration $t$ falls within the interval $(c_{k-1}, c_k]$, and $d_k = 0$ otherwise. Assuming only time-invariant variables in $x$, the integrated

[14] According to preliminary results for the data of this study, the Weibull hazard produce the same diagnostics as in Pudney and Thomas; an unrealistically large value of the Weibull parameter. This suggests a more flexible specification of the base-line.

hazard becomes

$$\Lambda(t|x) = \int_0^t h(s|x)ds = \lambda(x)\left[\sum_{k=0}^{m} b_k\theta_k + (t - c_m)\theta_{m+1}\right] \tag{7}$$

where $b_k = c_k - c_{k-1}$, $c_m < t \leq c_{m+1}$ and $m = 0, 1, ..., M - 1$. The density function in turn is

$$f(t|x) = h(t|x)S(t|x).$$

Define $c_i = 1$ if the duration of individual $i$ is uncensored and $c_i = 0$ otherwise. The log-likelihood function allowing for censored observations is then

$$\ell_0 = \sum_{i=1}^{n} [c_i \ln f(t_i|x_i) + (1 - c_i) \ln S(t_i|x_i)] = \sum_{i=1}^{n} [c_i \ln h(t_i|x_i) - \Lambda(t_i|x_i)] \tag{8}$$

which is maximized with respect to $\beta$ and $\gamma_k$ in eq.(7).

## 4.2 Multiple exit routes and allowing for infinite durations

Assume that there are several exit routes from unemployment and that the set of exogenous variables, $x$, their impact on duration, $\beta$, and also the time specific constants, $\gamma_k$, are allowed to vary across exit routes. Each individual will leave unemployment through at most one exit route. Define $r_{ij} = 1$ if individual $i$ exits through route $j$ and $r_{ij} = 0$ otherwise. The dummy variable $c_i = \sum_j r_{ij}$ equals one for the uncensored observations while $c_i = 0$ for those who have experienced a duration exceeding a maximum limit, say $t^{\max}$, for all $q$ exits. The log-likelihood function, assuming independence between exits and suppressing conditioning on $x$, is then

$$\ell_2 = \sum_{i=1}^{n}\left[\sum_{j=1}^{q} r_{ij} \ln f(t_{ij}) + (1 - r_{ij}) \ln S(t_{ij})\right] = \sum_{i=1}^{n}\left[\sum_{j=1}^{q} r_{ij} \ln h(t_{ij}) - \Lambda(t_{ij})\right] \tag{9}$$

As long as independence between exits is assumed, ML estimation of the $q$ durations can be made separately.

Now, we will allow for infinite durations stemming from the fact that all $q$ exit routes might not be relevant to everyone in the population. Let $P_{ij}$ be the probability that exit route $j$ is not relevant to individual $i$, i.e. the probability that duration $t_{ij}$ is infinite. Whenever one or several $P_{ij}$:s are positive, we have a defective risk problem, which is characterized by

$$\lim_{t\to\infty} S(t) > 0$$

(see Lancaster, 1990, p. 9). In a "standard" CR model, the probability of an observation to be censored originates from the probability of surviving exits. When allowing for infinite durations, the probability of censoring will be more complicated. We must now take into account that censoring may stem from both surviving exits and from not even searching particular exits routes (i.e. infinite durations). With positive probabilities of infinite durations the likelihood function is, for each individual $i$,

$$\ell_{3i} = \sum_{j=1}^{q} r_{ij} \left\{ (\ln(1-P_{ij}) + \ln f(t_{ij})) + \sum_{m=1, m\neq j}^{q} \ln((1-P_{im})S(t_{im}) + P_{im}) \right\} + \\ +c_i \ln \Pr(c_i = 1) \tag{10}$$

where $\Pr(c_i = 1)$ is the probability that individual $i$ is censored. Assuming three exits, suppressing individual indices and using the notation $P_1 = \Pr(t_1 = \infty)$, $P_{123} = P_1 P_2 P_3$, $q_1 = (1 - P_1)$ etc., the probability of censoring is

$$\Pr(c_i = 1) = P_{123} + P_{12}q_3S_3 + P_{13}q_2S_2 + P_1q_2S_2q_3S_3 + \\ P_2q_1S_1q_3S_3 + P_3q_1S_1q_2S_2 + q_1S_1q_2S_2q_3S_3. \tag{11}$$

The $P_{ij}$:s will be modelled as unknown parameters constant across individuals.[15] For the model represented by the likelihood contributions in eq.(10) the $q$ exits are still assumed independent. However, from the definition of the censoring probability of eq.(11), all exits must now be estimated simultaneously.

## 4.3 Unobserved heterogeneity

Allowing for infinite durations as described above, will hopefully capture some of the heterogeneity among the unemployed. I will also assume heterogeneity of the form where the individual specific component in the hazard is multiplied with an individual specific error term, $v$, which is assumed to be independent of both $t$ and $x$ (see e.g. Lancaster, 1979). The survivor function, conditional on $v$, is

$$S(t|x, v) = \exp[-\Lambda(t|x)v] \tag{12}$$

and the hazard consequently

$$h(t|x, v) = h(t|x)v. \tag{13}$$

[15] The probabilities may also be functions of individual characteristics, e.g. as binary logit-probabilities (see Pudney and Thomas, 1995).

For mathematical convenience the error term reflecting heterogeneity is often assumed to be Gamma distributed. The PC hazard model with Gamma heterogeneity is shown in Appendix and the resulting log likelihood function, taking into account only one exit, is

$$\ell_4 = \sum_{i=1}^{n} [c_i \ln h(t_i|x) + (\eta + c_i)(\ln \eta - \log[\Lambda(t_i|x) + \eta])] \tag{14}$$

which requires only one more parameter, $\eta = \sigma^{-2}$, compared to the same model without heterogeneity. The survivor function accounting for Gamma heterogeneity is

$$S_h(t_i|x) = \frac{\eta^{\,\eta}}{(\Lambda(t_i|x) + \eta)^{\,\eta}} \tag{15}$$

while the corresponding hazard rate is

$$h_h(t) = \frac{\eta}{(\Lambda(t_i|x) + \eta)} h(t_i|x). \tag{16}$$

The density function is consequently

$$f_h(t_i|x) = h_h(t_i|x) S_h(t_i|x) = \frac{\eta^{\,\eta+1}}{(\Lambda(t_i|x) + \eta)^{\,\eta+1}} h(t_i|x). \tag{17}$$

A multiple exit model with Gamma heterogeneity in a piece-wise constant setting, is easily formulated by using eqs.(15-17) in the likelihood function of eq.(9) or, allowing also for infinite durations, in the likelihood of eq.(10).

# 5 Empirical results

In Tables VI and VII the estimated parameters from the hazard models are summarized.[16] The base-line hazard is for most exits and subsamples constant across time or slightly increasing with time. However, for the exit by leaving the labor force, the hazard shows stronger positive duration dependence, i.e. the probability of leaving the labor force increases along the unemployment spell.

For the heterogeneity parameter $\sigma^2$ we see that heterogeneity of this form is most important for the exit to subsidized/sheltered employment, for subsamples $A$ and $C$. The estimated probabilities of infinite durations vary quite a lot across exits and subsamples, where the smallest probabilities are found for subsample $A$

[16] All estimations have been made in GAUSS and the program code is available from the author on request. Only a random 50 percent of each sub-sample have been used, due to very long processsing times for large samples.

(no program participation during unemployment spell). If the model is estimated with the restriction $P_j = 0$ for all $j$ exits (these restricted estimation results are not included in the paper) this leads to an upward bias of the variance of the Gamma heterogeneity, $\sigma_j^2$, and also a downward bias of the base-line.

Table V: Summarized information from estimation of the competing risk model allowing for infinite latent durations. Subsamples are (A) No programs and (B) Only vocational rehabilitation.

| Subsample | (A) | | | (B) | | |
|---|---|---|---|---|---|---|
| Exit | (1) | (2) | (3) | (1) | (2) | (3) |
| Duration < 180 days (=1) | -5.6 | -12.2 | -4.2 | -3.9 | -9.2 | -5.3 |
| Duration 180-359 days (=1) | -5.7 | -11.8 | -4.0 | -3.4 | -8.0 | -4.3 |
| Duration 360-539 days (=1) | -5.5 | -11.1 | -3.8 | -3.0 | -7.6 | -4.0 |
| Duration > 539 days (=1) | -5.8 | -10.3 | -3.8 | -2.7 | -7.4 | -3.9 |
| Male (=1) | +++ | +++ | −−− | ++ | ++ | −−− |
| Age, ln | −−− | +++ | −−− | −−− | + | − |
| UI benefits (=1) | +++ | −−− | −−− | | | −−− |
| Cash assistance (=1) | +++ | −−− | −−− | | | −−− |
| Physical handicap (=1) | +++ | −−− | −−− | | − | |
| Unemployment rate | | −−− | | | | +++ |
| "Disability rate" | | | | + | | |
| "Program rate" | ++ | +++ | +++ | | +++ | +++ |
| University or high school (=1) | ++ | − | −− | | | − |
| Any prof. experience (=1) | +++ | +++ | −−− | | | −−− |
| $\sigma_j^2$ | 0.000 | 4.702 | 0.153 | 0.801 | 0.000 | 0.210 |
| $P_j$ | 0.003 | 0.003 | *0.040 | 0.166 | *0.200 | *0.106 |
| Share this exit | 0.14 | 0.19 | 0.49 | 0.10 | 0.32 | 0.47 |
| $-\ell/n$ | 6.145 | | | 7.054 | | |
| $n$ | 15,791 | | | 4,769 | | |

+++/−−− the effect is significant at the risk-level one percent.
++/−− the effect is significant at the risk-level five percent.
+/− the effect is significant at the risk-level ten percent.
Note: * the parameter is significant at the five percent risk level.

Among the individual specific variables there are some which have about the same effect across all subsamples. For example, men tend to be more probable to leave unemployment for regular, and also to some extent to subsidized/sheltered employment, and less probable for leaving the labor force. Individuals with a physical disability, as opposed to a psychological or social disability, are generally more probable to leave for regular employment. High-school or university education as

Table VI: Summarized information from estimation of the competing risk model allowing for infinite latent durations. Subsamples are (C) One program other than vocational rehabilitation and (D) Two or more programs.

| Subsample | (C) | | | (D) | | |
|---|---|---|---|---|---|---|
| Exit | (1) | (2) | (3) | (1) | (2) | (3) |
| Duration < 180 days (=1) | -5.7 | -13.3 | -2.5 | -9.2 | -12.1 | -4.0 |
| Duration 180-359 days (=1) | -5.1 | -11.9 | -1.7 | -7.7 | -9.0 | -2.5 |
| Duration 360-539 days (=1) | -4.7 | -11.3 | -1.2 | -7.1 | -8.6 | -1.9 |
| Duration > 539 days (=1) | -4.1 | -10.6 | -0.8 | -5.9 | -7.4 | -1.3 |
| Male (=1) | +++ | | −−− | +++ | | |
| Age, ln | −−− | +++ | −−− | −−− | ++ | −−− |
| UI benefits (=1) | | −−− | −−− | −−− | −−− | −−− |
| Cash assistance (=1) | −− | | −−− | | −−− | −−− |
| Physical handicap (=1) | +++ | −−− | −−− | +++ | | |
| Unemployment rate/10 | | | | | +++ | ++ |
| “Disability rate” /10 | | | | | | |
| “Program rate” /10 | ++ | +++ | +++ | ++ | +++ | +++ |
| University or high school (=1) | +++ | | −−− | ++ | −−− | |
| Any prof. experience (=1) | +++ | + | −− | | | −− |
| $\sigma_j^2$ | 0.541 | 2.202 | 0.520 | 0.002 | 0.004 | 0.002 |
| $P_j$ | 0.251 | 0.188 | *0.144 | 0.002 | *0.387 | 0.225 |
| Share this exit | 0.19 | 0.17 | 0.38 | 0.12 | 0.19 | 0.19 |
| $-\ell/n$ | 6.123 | | | 4.628 | | |
| $n$ | 6,104 | | | 5,945 | | |

+++/−−− the effect is significant at the risk-level one percent.
++/−− the effect is significant at the risk-level five percent.
+/− the effect is significant at the risk-level ten percent.
Note: * means that $P_j$ is significant at the five percent risk level.

well as previous professional experience increases the hazard rate for regular employment generally. The result that entitlement to benefits of any kind, education and previous labor market experiences increases the hazard to regular employment, is valid for all subsamples except for subsample $B$; workers who have participated in vocational rehabilitation only. Already according to Table V it is clear that after vocational rehabilitation only, the exit to regular employment is the least probable.

The variable reflecting unemployment at the local labor market has a positive effect on the hazard rate to withdrawal from the labor force and, for those with two or more programs, also for exit to subsidized/sheltered employment. The former effect can be interpreted as an indication of that early retirements may still be in use for labor market reasons. The overall positive effect of local *program rate* on all hazard rates is difficult to interpret. It may be that the program rate catches some other local attributes important to unemployment duration of disabled.

We want to compare briefly the results for the disabled workers (aged 25-55) of this paper with the results for the non-disabled workers (aged 16-55) in the paper by Carling et al. (1996). The results of the two studies are summarized in Table VIII. It may be mentioned again that the studies have quite different assumptions. In Carling et al. the duration in open unemployment is the variable of interest and participation in a policy program is considered an exit from unemployment. In this present study total unemployment - open and time in programs - is the dependent variable.

Table VII: Comparison of results for disabled and non-disabled workers (from Carling et al., 1996), respectively. The exits for the disabled are (1) Regular employment, (2) Subsidized/sheltered employment and (3) Non-participation inlabor force. For the non-disabled exit (2') is participation in a policy program. "0" means that the variabel is not included in the model.

| | Disabled | | | Non-disabled | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (1) | (2') | (3) |
| Male (=1) | + | + | − | − | − | − |
| Age, ln | − | + | − | − | − | − |
| UI benefits (=1) | +/− | − | − | − | − | − |
| Cash assistance (=1) | +/− | − | − | | − | − |
| Physical handicap (=1) | + | − | − | 0 | 0 | 0 |
| Unemployment rate | | | + | − | + | + |
| "Program rate" | + | + | + | | + | + |
| University or high school (=1) | + | − | − | + | + | − |
| Any prof. experience (=1) | + | | − | + | +/− | − |
| Share this exit | 0.14 | 0.20 | 0.41 | 0.46 | 0.17 | 0.15 |
| $n$ | 32,609 | | | 12,098 | | |

If we first consider the proportions leaving unemployment for a regular job and by withdrawing from the labor force, respectively, we see that the figures of the disabled are almost the "inverse" of those of the non-disabled. 14 percent of the disabled leave for a regular job and 41 percent leave the labor force. The corresponding figures of the non-disabled are 46 and 15 percent, respectively. Among the disabled workers, 20 percent leave for subsidized/sheltered employment while 17 percent of the non-disabled leave for a policy program.[17] The proportion of censored observations is thus 25 and 22 percent, respectively.

The effect of individual specific characteristics on the exit through leaving the labor force is practically equal for disabled and non-disabled. When it comes to leaving unemployment for a regular job there are a couple of differences to be commented on. First, among disabled, men are more probable than women to get a regular job, while the opposite holds for the non-disabled. Second, among non-disabled, entitlement to unemployment insurance benefits decreases the probability of finding a regular job, while the opposite holds for one of our subsamples of disabled, i.e. those who do not participate in any policy programs. In addition, while the local unemployment rate has a negative impact on the job probability for non-disabled, this is not the case for the disabled. These differences may well be interpreted as that those disabled who get regular jobs, even if the are few, they get these jobs quite independently of the local labour market situation. Besides, being entitled to unemployment benefits may both prolong unemployment by leading to less search and a higher reservation wage (the hypothesis in Carling et al.) but entitlement may also mean attachment to the regular labour market which makes it easier to return after a period of unemployment (for example by being recalled to a former employer). For the disabled workers this latter effect seems to be more important then the former.

# 6 Concluding remarks

It is very well known that the labor market opportunities of the unemployed disabled workers in Sweden is troublesome. However, little is known about the special conditions facing the disabled workers. The focus of this paper has been unemployment duration of disabled workers only. Two important differences between disabled and non-disabled unemployed is that the disabled participate in considerably more policy programs and also that about 20 percent of the group leave unemployment to subsidized/sheltered employment.

We have used a piece-wise constant hazard model, extended to account for unobserved Gamma heterogeneity and also unobserved heterogeneity due to differences in search behavior. It appears that the latter kind of heterogeneity is at least as

[17] From Table III we know that more than 50 percent of the disabled participate in one policy program or more. Thus, the disabled participate considerably more in policy programs than do non-disabled unemployed.

important as the former.

The results of the present paper have been compared to those of a similar study of non-disabled unemployed. It appears that for leaving the unemployment by withdrawing from the labor force, the behavior of the two groups are almost identical when it comes to variables explaining duration until this exit. However, when it comes to exit to regular employment there are two important differences between the groups. First, the quite few disabled who get regular employment after a period of unemployment, appear to get these in markets "separate" from the non-disabled. At least we see that the disabled are in this respect not dependent on the local unemployment rate, as are the non-disabled. Second, the entitlement to unemployment benefits, which in theory and also empirically for the non-disabled, *reduces* the probability of getting a regular job, while for the disabled who do not participate in any policy programs, entitlement *increases* the probability of finding a regular job. We know that benefits are expected to increase the reservation wage and lead to less search activities, and thereby prolong unemployment. However, entitlement to benefits also means that the workers has some previous labor market experience which may make it easier to find a new job or may lead to a recall by the former employer. For the disabled workers the former negative effect is probably offset by the latter positive effect on the probability of ending an unemployment spell.

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# Appendix

In order to account for individual heterogeneity, assume that there is an individual specific variable $v$ which is a non-negative Gamma-distributed term, with unit mean and parameter $\eta$, $v \sim \mathcal{G}(1, \eta)$, where $E(v) = 1$ and $V(v) = \sigma^2 = 1/\eta$. The density of a Gamma-distributed variable is

$$f(v|\alpha, \beta) = \frac{1}{\Gamma(\alpha)\beta^{\alpha}} v^{\,\alpha-1} \exp(-v/\beta) \tag{18}$$

with $E(v) = \alpha\beta$ and $V(v) = \alpha\beta^2$. In our case $\alpha = \eta$ and $\beta = \eta^{-1}$, which means that the density of the Gamma-distributed error term is

$$f(v) = \frac{\eta^{\,\eta}}{\Gamma(\eta)} v^{\,\eta-1} \exp(-\eta v). \tag{19}$$

The conditional survivor function (i.e. conditional on the heterogeneity term) is then

$$S(t|x, v) = \exp[-\Lambda(t|x)v] = \exp[-\Lambda v]. \tag{20}$$

We get the unconditional survivor function by integrating out the heterogeneity term $v$ from $S(t|x, v)$, as

$$S_h(t|x) = \int_0^{\infty} S(t|x, v) f(v) dv = \tfrac{\eta^{\,\eta}}{\Gamma(\eta)} \int_0^{\infty} v^{\,\eta-1} \exp(-\eta v) \exp[-\Lambda v] dv =$$
$$= \tfrac{\eta^{\,\eta}}{\Gamma(\eta)} \int_0^{\infty} v^{\,\eta-1} \exp(-(\Lambda + \eta)v) dv.$$

Assign the following notation; $\Lambda + \eta = \beta$ and $\eta = \alpha$, and the survivor can be written as

$$S_h(t|x) = \frac{\eta^{\,\eta}}{\Gamma(\eta)} \frac{\Gamma(\alpha)}{\beta^{\,\alpha}} \int_0^{\infty} \frac{\beta^{\,\alpha}}{\Gamma(\alpha)} v^{\,\alpha-1} \exp(-\beta v) dv = \frac{\eta^{\,\eta}}{\Gamma(\eta)} \frac{\Gamma(\alpha)}{\beta^{\,\alpha}} = \frac{\eta^{\,\eta}}{(\Lambda + \eta)^{\,\eta}} \tag{21}$$

where the simplification follows since the integral equals unity. The hazard rate taking into account individual Gamma heterogeneity is then derived as

$$h_h(t|x) = -\frac{d \ln S_h(t|x)}{dt} = \eta \frac{d}{dt} \ln(\Lambda + \eta) = \frac{\eta}{(\Lambda + \eta)} h(t|x). \tag{22}$$

This means that the Log likelihood-function will be

$$\begin{aligned} \ell_h &= c \ln h(t|x) + c \ln \eta - c \ln[\Lambda(t|x) + \eta]) + \eta \ln \eta - \eta \ln[\Lambda(t|x) + \eta]) = \\ &= c \ln h(t|x) + (\eta + c)(\ln \eta - \ln[\Lambda(t|x) + \eta]) \end{aligned} \tag{23}$$

where $h(t|x)$ and $\Lambda(t|x)$ refer to the case without heterogeneity.

What then, if there is no heterogeneity and thus $V(v) = \sigma^2 = 1/\eta = 0$? The limiting value of the likelihood can be shown to be

$$\lim_{\sigma^2 \to 0} (c \ln h(t|x) + (\eta + c)(\ln \eta - \ln(\Lambda(t|x) + \eta))) = c \ln h(t|x) - \Lambda(t|x) \tag{24}$$

which is simply the ordinary likelihood function without heterogeneity.