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Henning Bach
Nabanita Datta Gupta
Jan Høgelund

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Henning Bach[A], Nabanita Datta Gupta[A, B], Jan Høgelund[A]

[A]*Danish National Institute of Social Research*
Herluf Trolles Gade 11, 1052 Copenhagen K, Denmark.
[B]*NBER, Cambridge, MA and IZA, Bonn*

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Abstract

Vocational rehabilitation in the form of education is the cornerstone of governmental rehabilitation programs for the work-disabled in many countries. Merging a 2004 Danish survey to register information from the Danish National Board of Industrial Injuries, we assess the employment effects of educational measures for the work-injured, by simultaneously estimating the hazard rate to education and the return to work, controlling for unobserved heterogeneity and the endogeneity of education. In addition, we allow for any enhanced employment effects of a unique wage subsidy program in Denmark, giving employers a partial wage subsidy for disabled workers' wages, by distinguishing between education effects of a return to wage-subsidized work versus a return to ordinary work. Unlike previous studies, we find a positive impact of educational measures on the probability of returning to work for the work injured and a stronger effect for a return to wage-subsidized employment compared to a return to ordinary employment.

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1. Introduction

Work disability is a serious economic and societal problem in most countries. In the developed countries the number of disability beneficiaries makes up more than 6 percent of the adult population (OECD, 2003). In addition, recipients of sickness benefits and workers' compensation benefits comprise between 3 and 7 percent of the labor force (Einerhand et al., 1995). The development of disabilities is often related to work; 20 to 58 percent of people with disabilities report in surveys that the onset of their disability was related to work (Eurostat, 2005, Bengtsson, 1997).[1] Even though the number of work accidents is declining in many countries (Eurostat, 2005), the cost of workers' compensation has been rising over time, with moral hazard consequences particularly in the case of hard-to-verify injuries such as strains, back problems or unspecified injuries (Butler et al., 1996). Therefore, finding ways to maintain the labor market ties of people injured at work remains an important issue.

Several countries, including Denmark, use vocational rehabilitation as the most important device for increasing the labor attachment of disabled people (EIM, 2002). The Danish vocational rehabilitation policy is largely based on educational measures. Courses and education ranging from short-term vocational education (e.g. lasting one year) to post-secondary education at the university level make up between two-thirds and three-quarters of the established measures in the vocational rehabilitation program (Storm, 2001).[2] In this paper we investigate whether vocational rehabilitation involving education for work-injured people increases their chances of returning to work.

Work injury is expected to result in a loss of human capital**.** As a direct result of the injury, the worker may lose some of his or her productive capacity on the job, resulting in a diminished ability to perform the job at the same intensity level as before or a deceased ability to perform the same tasks as before. In addition, an indirect effect on human capital arises if job skills depreciate during the individual's time away from the labor market during treatment and recuperation. The participation of work injured people in education should increase their human capital and thus improve their re-employment chances.

Vocational rehabilitation in the form of education may also reduce the risk of recurrence of the same work injury because acquisition of new educational skills enables the injured in-

[1] These differences are probably largely related to differences in the definition of being disabled and in the formulation of the questions that measure whether or not the disability is related to work.
[2] Wage-subsidized job training, test of working capacity, and other measures make up between one-quarter and one-third of the measures.

dividual to return to work with new tasks. Furthermore, compared to costly workplace accommodations such as providing ergonomically designed workstations, etc., general tax-financed educational measures do not impose a financial burden on employers.[3] In sum, participation in education should increase injured workers' productivity, improve the quality of their job match, prevent re-injury and thereby increase their labor market attachment.

Several American and European studies have assessed the impact of vocational rehabilitation on different labor market outcomes. While American cost-benefit studies support the merits of vocational rehabilitation (e.g. Lewis et. al., 1992; Dean, Dolan and Schmidt, 1999), the European studies yield mixed evidence (e.g. Aakvik, Heckman, and Vytlacil, 2005; Heshmati, Engström, 2001). The studies that have assessed the effect of educational measures suggest that they have a limited, or even a negative employment effect. In relation to our study, these studies suffer from two drawbacks. They did not distinguish between people who were injured at work and people who were disabled for other reasons. In addition, none of these studies allowed for a differential effect of education on return to work, depending on whether it was to wage-subsidized or ordinary employment.

In the literature, including American and European studies, no sound evidence about the employment effects of vocational rehabilitation among work-injured people seems to be at hand. The lack of a comparison group or instruments to control for the unobserved selection into vocational rehabilitation hampers the reliability of previous studies, cf. section 2.

This study helps to fill in this gap by providing new evidence about the employment effects of vocational rehabilitation measures involving education for work-injured people, taking into account the unobserved selection into the treatment. We use data about 1,620 work-injured persons to estimate a random effects hazard model. We simultaneously estimate transitions to educational measures and to both wage-subsidized employment and ordinary employment. We find that educational measures have a positive impact on the probability of returning to work for the work-injured and that this effect is stronger for a return to wage-subsidized employment compared to a return to ordinary employment.

In section 2, we provide a review of studies about the employment effects of vocational rehabilitation. Section 3 outlines the Danish workers' compensation program and other disability-related social security programs. Section 4 describes the data and section 5 outlines the eco-

[3] Estimates of average workplace accommodation costs range between $500 per accommodation (Job Accomodation Network figures) to over $1000, excluding administrative and managerial costs, and tend to be absorbed mainly by employers (Gunderson and Hyatt, 1996).

nomic model. We present the estimation results in section 6 and conclude the paper in section 7 with a brief discussion of our findings.

2. Previous studies

While only few studies exist about the employment effects of vocational rehabilitation in workers compensation beneficiaries, several studies have investigated this issue in other populations.

First, there has been a long tradition of evaluating labor market outcomes of the US vocational rehabilitation programs. This tradition, which can be traced back to the early 1920s (Lewis et al., 1992), applies a cost-benefit approach to estimate whether participation in vocational rehabilitation yields a positive net outcome, i.e. whether the economic outcome for individuals participating in the programs exceeds program costs. This literature generally agrees that vocational rehabilitation generates positive outcomes (see Berkowitz et. al., 1988; Dean and Dolan, 1991; Lewis et. al., 1992; Wood and Morrison, 1997; Dean, Dolan and Schmidt, 1999). With respect to a measurement of employment effects of vocational rehabilitation for work-injured people, the studies suffer from two drawbacks. The study populations include all participants in vocational rehabilitation, not only workers' compensation beneficiaries. Given no distinction between workers' compensation beneficiaries and other participants, these studies do not provide estimates of the effectiveness of vocational rehabilitation for work-injured people. Furthermore, because the cost-benefit estimates are composed of both an earnings effect and an employment effect, these studies do not directly measure employment effects of vocational rehabilitation.[4]

Second, several European studies have assessed the effect of vocational rehabilitation measures for work-disabled people (Schmidt, Oort-Marburger, Meijman, 1995; Heshmati, Engström, 2001; Høgelund 2003; Høgelund and Holm, 2005; Aakvik, Heckman, and Vytlacil, 2005; Frölich, Heshmati, Lechner, 2004; Høgelund and Holm, 2005). These studies focus on individuals on sick leave, meaning that the populations comprise people with and without work-related disabilities.[5] All the studies took possible problems of unobserved selection into the treatment into account. The studies provide mixed evidence. Some studies found that vocational rehabilitation has no effect

[4] Two exceptions are Gibbs (1990) and Hennessey and Mueller (1995). Gibbs (1990) found that participation in vocational rehabilitation increases the duration of subsequent employment spells and reduces the duration of subsequent unemployment spells. Hennessey and Mueller (1995) found that vocational rehabilitation increases disability beneficiaries' employment chances. However, these findings may be biased, because no adjustments for unobserved differences between the participants and the non-participants was made.

[5] Schmidt, Oort-Marburger, Meijman (1995) and Aakvik, Heckman, and Vytlacil (2005) also studied people with and without work-related disabilities; however, in contrast to the other studies, the sample was not restricted to people on sick leave.

or even a negative employment effect (Aakvik, Heckman, and Vytlacil, 2005; Frölich, Heshmati, Lechner, 2004), whereas other studies found a positive effect (Schmidt, Oort-Marburger, Meijman, 1995; Heshmati, Engström, 2001).

The only study we have found, Frölich, Heshmati, Lechner (2004), distinguished between five different types of vocational rehabilitation, i.e. workplace rehabilitation, education, medical rehabilitation, social rehabilitation, and passive rehabilitation (various types of assessments). None of the measures were found to yield positive employment effects. Workplace rehabilitation was the most efficient measure, but sick-listed who participated in this measure had the same probability of returning to work as those who did not participate in vocational rehabilitation. Education was the least efficient measure with a strong and negative employment effect. The limited effect of educational measures is supported by Høgelund and Holm (2005), who found a negative lock-in effect during participation in the measure and a positive effect of the same size of having terminated the measure.

While our primary focus is on the employment effects of education, we additionally allow for any enhanced employment effects of a Danish wage subsidy program giving employers a partial wage subsidy of up to 67 percent of disabled workers' wages, by distinguishing between the education effects of a return-to-wage-subsidized employment versus a return-to-ordinary employment. That is, we allow for a varying "treatment" effect of education (Heckman, Smith and Clements, 1997), depending on whether the return-to-work job is an ordinary job or a wage-subsidized job offering a partial wage subsidy to employers and sheltered working conditions for workers.

Only few studies appear to have assessed the effect of educational measures for workers' compensation beneficiaries. The lack of good data and of comparison groups seems to be the reason why no thorough evaluations have been made in the US. For example, Gardner (1988) compared the effect of different vocational rehabilitation measures under the workers' compensation program in Florida, but without a control group he was unable to estimate whether participation in the various vocational rehabilitation measures was better than non-participation. Gardner's (1986) evaluation of vocational rehabilitation under the New York workers' compensation program also suffered from the lack of a comparison group.

An evaluation of the Canadian workers' compensation vocational rehabilitation programme suggests that vocational rehabilitation harms the participants' probability of returning to work (Allingham and Hyatt, 1995). To control for endogeneity of the vocational rehabilitation covariate, the authors use the instrumental variables approach. As an instrument they use whether or not the employer's contribution to the work injury insurance is experienced-rated. However, as Allingham and Hyatt note, this instrument is far from perfect because it is likely that experience rating influences not only the probability of participating in vocational rehabilitation but also the probability of returning to work. Therefore, it is possible that the negative employment effect merely reflects that vocational rehabilitation participants have lower ex ante employment chances than non-participants.

To sum up, many studies on the effect of vocational rehabilitation for disabled people exist. These studies do not specifically focus on work-injured people, and they provide mixed evidence on the effect of vocational rehabilitation. Although the studies that have assessed the effect of educational measures suggest that they have a limited employment effect, none of these studies have allowed for a differential effect of education on return to work, depending on whether the return is to wage-subsidized or ordinary employment. Only few studies on the vocational rehabilitation of work injured people appear available. The best of these studies, which indicates that vocational rehabilitation has a negative employment effect, suffers from problems with endogeneity.

3. The Danish disability policy

In US for example, people injured at work are normally covered by a single earnings compensating program, a state regulated workers' compensation program. In contrast, work-injured people in Denmark are covered by two programs: the sickness benefit program and the workers' compensation program.

The national sickness benefit program provides a sickness benefit to workers, unemployed, and self-employed people who are partly or fully unable to work because of illness or injury. No distinction is made between work- and non-work-related illness and injury. The program gives full wage compensation up to a cap that equals the maximum unemployment benefit. Many employers top up sickness benefit to the wage level. The benefit can normally be received for a maximum of 52 weeks within a period of 18 months, but in certain cases benefit receipt may be prolonged, e.g. if a work injury compensation claim has not been settled. The employer finances sickness benefits for the first two weeks, and the state and local authorities (municipalities) take over for the remaining period.

The sickness benefit program is administered by the municipalities, which also administer the vocational rehabilitation program and other social security programs (except the unemployment insurance). The municipality is obliged to follow up all sickness benefit cases within eight weeks of sick leave; thereafter follow up assessments are to take place at least every 8th week. The assessments make sure that conditions for continued benefit receipt are fulfilled and to improve the beneficiaries' attachment to the labor market. To promote work resumption, the municipal case manager can establish various vocational rehabilitation measures, including workplace adaptations, aids, tests of working capacity, working trial periods, job counselling, wage-supported job training and education.

Education measures range from short-term vocational courses to post-secondary education at the university. Labor market training schools (AMU schools) offer vocational courses such as PC or fork-lift courses directed at employment in specific sectors. These courses last from few weeks to several months. The AMU schools are state regulated, self-governing institutions partly funded by the state. The formal vocational education and training program (VET) combines theoretical and practical education in a vocational college with training in a company, thereby preparing the participants for employment in various branches such as craft, service, and transportation industries (CIRIUS, 2006). The VET educations, lasting for two to five years, take place at various vocational colleges. These colleges are state regulated and either are self-governing institutions funded by the state or are institutions owned and funded by the county.

Vocational rehabilitation, including education measures, takes place under the vocational rehabilitation program.[6] A rehabilitee can receive vocational rehabilitation benefit, which equals the sickness benefit, for up to five years.

If an injured worker with permanently reduced working capacity, despite participation in vocational rehabilitation, cannot return to ordinary employment, the municipality many refer the worker to a permanent wage-subsidized job (*flexjob*). The flexjob program comprises jobs on special working conditions, for example, reduced working hours, adapted working conditions, and restricted job demands. In addition, employers who hire workers approved for flexjobs are entitled to a partial wage subsidy corresponding to either 50 percent or 67 percent of the wage as stipulated in the relevant collective agreement.

When an injured worker is unable to work in a flexjob, he or she is eligible for a disability benefit. The benefit is equal to the unemployment benefit. Disability beneficiaries with re-

[6] If the aim of a vocational rehabilitation measure is to identify the abilities of the sick-listed individual, e.g. to test working capacity, the measure may take place in either the vocational rehabilitation program or the sickness benefit program. The same is true if the measure is considered preparation for participation in postsecondary education, e.g. education at the university level.

sidual working capacity may apply for a wage-subsidized job. These jobs are adjusted to the limited working capacity of the disability beneficiaries, meaning that the working hours and job tasks are significantly reduced. The employer is normally entitled to a wage subsidy of DKK 21 ($3.5) per working hour in 2006 (if the worker is handicapped, the employer may receive a subsidy of up to DKK 115 ($19) per hour).

The workers' compensation program is parallel to the sickness benefit program. The program covers all employed people and provides compensation for work accidents and work-related diseases. The program gives compensation for permanent reduction of occupational abilities and eligibility requires medically proof that the injury is work-related and that it causes a permanent reduction of occupational abilities of at least 15 percent.[7] Decisions about benefit awards rest with the National Board of Industrial Injuries (*Arbejdsskadestyrelsen*). Benefits are financed by employers, who are obliged to take out a policy with a private accident insurance company.

The compensation for reduction of occupational abilities is paid as a lump sum if the ability reduction is below 50 percent and as a monthly benefit if the reduction exceeds 50 percent. The compensation is equal to 80 percent of the previous wage times the degree of ability reduction. Wages are only compensated up to DKK 396.000 ($64.000) per year.

Workers can simultaneously receive workers' compensation and other social security benefits. Generally speaking, the compensation is either not deducted from other benefits or only partly deducted, meaning that the total benefit amount can potentially exceed previous wage payments. With the exception of disability benefits, the compensation for reduction of daily life abilities is not deducted from other benefits. Compensation for reduction of occupational abilities does not affect the entitlement to other benefits if the degree of ability reduction is below 50 percent. If the compensation exceeds this threshold, it may lead to a reduction of vocational rehabilitation and disability benefits, depending on previous wage (vocational rehabilitation benefit) or capital income (disability benefit).

[7] In addition, the scheme comprises payment of expenses to necessary medical treatment and rehabilitation, and compensation for disutility caused by permanent reduction of daily life abilities.

4. Data and descriptive statistics

Our analysis is based on a random sample among people who were exposed to a work accident after 1995 and awarded a compensation for reduction of occupational abilities during 2002 and 2003. We contacted 2,580 persons for a telephone or face-to-face interview during December 2004 and January 2005. Interviews were obtained with 2,019, a response rate of 78 percent. We exclude 80 persons who did not report sick due to an accident and 83 persons who at the time of the injury were over 59 years old. Finally, we exclude 236 persons with missing information on the dependent variables or on the covariates. These exclusions leave us with an analytical sample of 1,620 persons.

The survey data includes information about the timing of participation in educational measures and the timing of return to work in either a wage-subsidized job or an ordinary job. The survey data were merged with register information from the National Board of Industrial Injuries. The register data contain information about the injured part of the body and the type of injury.

Our two dependent variables are defined as the duration from the first day of sick leave until (1) returning to ordinary work and until (2) returning to wage-subsidized work, in terms of either a flexjob or a subsidized job for disability beneficiaries. Sixty-two percent of our sample returned to work. Among these 1,016 persons, 711 (70 percent) returned to ordinary work, while 305 (30 percent) returned to subsidized work (see Table 1).

Participation in an educational measure is measured in two covariates. One covariate measures the time until enrollment in the measure. It is coded as 0 until enrollment, as 1 during participation, and as 0 after the measure is ended. Another covariate measures the time that has elapsed after the measure is ended. It is set to 0 until the measure is ended and 1 after the measure is terminated. Of the injured workers 219 (14 percent) participated in an educational measure, which in average lasted 14 months (see Table 1).

Table 1. Mean, standard deviation and deciles (n=1,692).

	Mean	Std.dev	10% decile	90% decile
Enrolled in an educational measure	0.135	0.342	0	1
Duration of educational measure[1)]	13.712	14.619	1	37
Return to ordinary work	0.439	0.496	0	1
Return to wage-subsidized work	0.188	0.391	0	1
Female (yes=1)	0.409	0.492	0	1
Age	41.610	10.313	27	55
Ethnic background (other than Danish=1)	0.040	0.196	0	0
Cohabitation status (Living with spouse=1)	0.778	0.415	0	1
Educational attainment				
Primary education[2)]	0.311	0.463	0	0
Vocational education	0.358	0.480	0	1
Short higher education[3)]	0.196	0.397	0	1
Medium-long and long higher education	0.135	0.341	0	1
Seniority (number of months)	86.103	99.160	2.736	247.352
Seniority information missing (yes=1)	0.035	0.183	0	0
Injured part of the body				
Neck and head	0.156	0.363	0	1
Back	0.378	0.485	0	1
Body	0.038	0.191	0	0
Upper extremity	0.209	0.406	0	1
Lower extremity	0.153	0.360	0	1
Multiple or general injuries	0.059	0.235	0	0
No information on injured part of body	0.007	0.082	0	0
Type of injury				
Fracture and amputation	0.170	0.376	0	1
Wound etc.	0.170	0.376	0	1
Strain and slipped disc	0.625	0.484	0	1
Unknown injury type	0.035	0.183	0	0
Industrial branch (of injury company)				
Agriculture, electricity supply, water and gas supply	0.092	0.289	0	0
Production	0.119	0.323	0	1
Construction	0.178	0.383	0	1
Trade, hotel, banking, real estate	0.099	0.299	0	0
Transportation	0.144	0.352	0	1
Public administration, education	0.073	0.261	0	0
Health and social services	0.221	0.415	0	1

Information on industrial branch missing	0.073	0.260	0	0
Company size (number of workers at injury company)	145.882	543.549	3	250
Municipalities' vocational rehabilitation tendency[3)]	0.028	1.035	-0.973	1.298
Unemployment rate, see table A.1 in Appendix				

1): Calculation based on the 219 persons who participated in a measure. For individuals who had not terminated their educational measure during the observation period, the mean is based on censored durations.

2): Primary education covers the compulsory school period, i.e. nine years of basic school, and other preparatory schooling such as high school.

3): Including certain vocational educations

4): Measured as the extent to which the injured workers' residence municipality awarded more or fewer vocational rehabilitation benefits than the national average (see text for details).

Figure 1 shows the unadjusted Kaplan-Meier hazard rate to participation in an educational measure, while Figure 2 shows the hazard rates to wage-subsidized employment and ordinary employment.

Figure 1: Unadjusted hazaed rate to educational measures

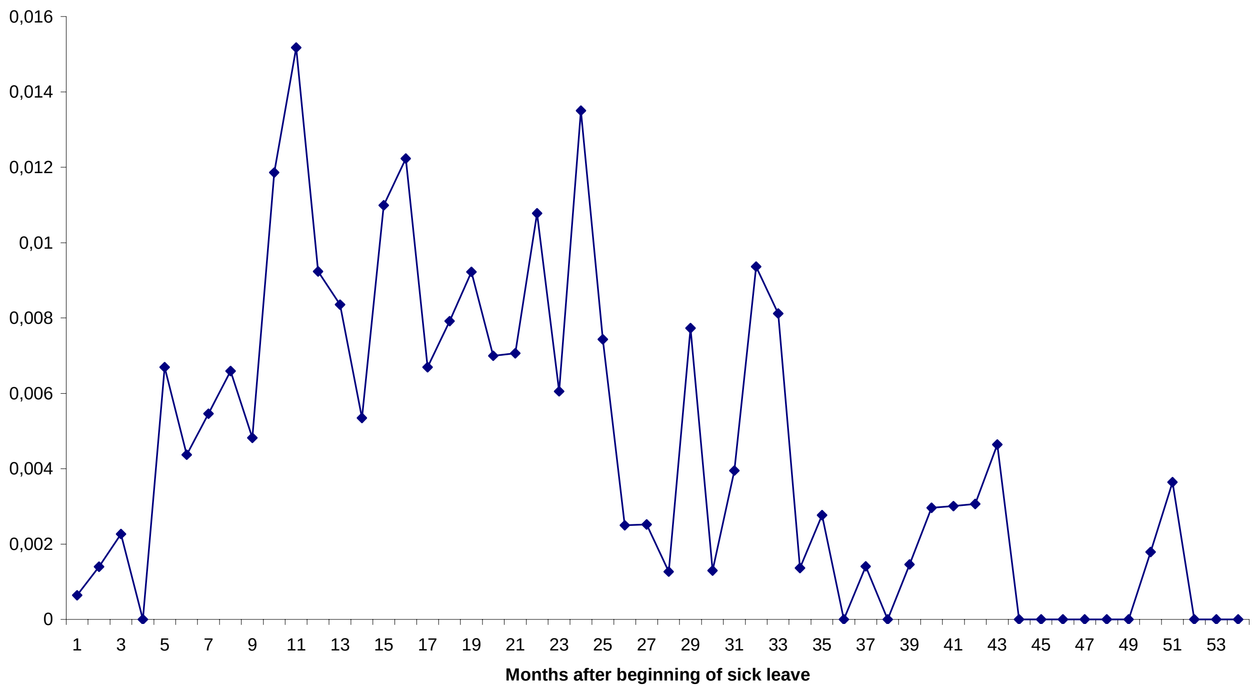
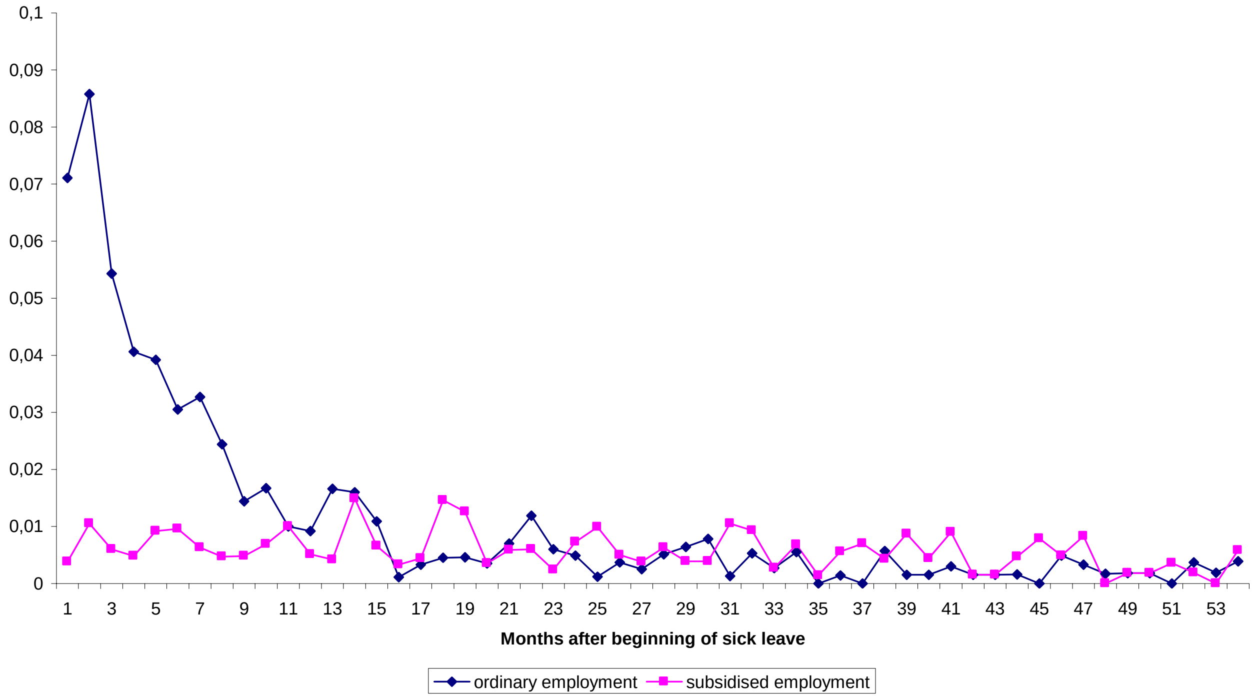


Figure 2: Unadjusted hazard rates to ordinary work and wage-subsidised work



The unadjusted hazard rates do not suggest that injured workers' participation in education increase the chance of returning to work. The probability of participating in an educational measure is biggest between the 10th and the 23rd month after the beginning of the sick leave, whereas return-to-work in ordinary employment often takes place at an earlier stage, i.e. between the first and the eight month after the first day of sick leave. Figure 1 shows that the hazard rate to wage-subsidized employment is almost constant, which makes it difficult to judge whether educational measures have a positive effect on the chance of returning to wage-subsidized employment.

The explanatory covariates include two health measures, six measures of socio-economic characteristics of the injured worker, two measures of characteristics of the injury-employer, and a measure of the unemployment level. One health measure comprises information about the injured part of the body, and another covariate measures the type of injury ('fracture and amputation', 'wound etc.', 'strain and slipped disc', and 'unknown injury type'). The socio-economic measures include gender, age, ethnic background, cohabitation status, educational background, and seniority in the work-injury job, measured at the time when the injury occurred. Characteristics of the injury employer include industrial sector and number of workers. Finally, to correct for the possible influence of demand fluctuations of the regional labor markets on the injured workers' probability of returning to work, we include the regional unemployment rate in our estimations of the probability of returning to work. This time-varying covariate is measured as the lagged unemployment rate, and it follows changes in the observed unemployment rate every sixth month.[8] Table 1 shows descriptive statistics for the explanatory covariates.

Unobserved differences between people in the treatment and comparison group are an important issue in all econometric effect assessments, because such differences may bias the estimate of the treatment effect. We apply two devices to correct for unobserved heterogeneity. First, we use the instrumental variables approach. This approach presupposes at least one variable that influences the probability that the injured worker participates in an educational measure but that does not influence the probability that the injured worker resumes work. Following Aakvik, Heckman, and Vytlacil (2005), we use the municipalities' tendency to use vocational rehabilitation as an instrument.

For each municipality we measure the extent to which the number of people receiving vocational rehabilitation benefit deviates from the average of the 275 Danish municipalities. We obtain this figure from OLS regressions. The dependent variable is defined as the ratio of adult inhabitants (in the injured worker's residence municipality) who received vocational rehabilitation benefit. Municipalities that often use vocational rehabilitation may do so, not because of an active vocational rehabilitation policy, but because they have many clients who are in the target group for this service. We therefore adjust for structural conditions that may influence the demand for vocational rehabilitation. These covariates, all measured relatively to the adult population, include the number of sickness beneficiaries, the number of social assistance beneficiaries,[9] the number of owned residences, and the number of homes with four rooms.[10] We use the standardized residuals from eight year-specific OLS regressions (1997-2004) to measure the municipalities' use of vocational rehabilitation. To each person in our sample we attach one residual. For injured workers reporting sick in 1996 we use the standardized residuals from an OLS-regression based on 1997 data, and for workers reporting sick in 1997 we use the residuals from an OLS-regression based on 1998 data, etc. (see Table 1 for descriptive statistics of the covariate). We introduce this one-year time lag because the decision to establish vocational rehabilitation often takes place several months after the

[8] The covariate is based on information about the quarterly unemployment rate. The average of the unemployment rate in the two quarters before the beginning of a sick leave period is allowed to affect the probability of returning to work during the first six months of the sick leave. Similarly, the average unemployment rate during the two first quarters of the sick leave period is allowed to affect the probability of returning to work during the next six months etc.
[9] Like sickness beneficiaries, people on social assistance may enter the vocational rehabilitation program.
[10] The regression is based on data from Statistics Denmark (Danmarks Statistiks Databank).

beginning of the sick leave. In our data, the educational measures began on average 19 months after the injured workers' reported sick.

Using this instrument, we assume that injured workers from municipalities that often use vocational rehabilitation have a higher probability of participating in an educational measure than injured workers from municipalities that seldom use vocational rehabilitation. At the same time, we assume that the municipalities' use of vocational rehabilitation does not affect the individual injured worker's chance of returning to work, except indirectly through his or her participation in an educational measure.

With only one instrument, it is impossible for us to test whether all necessary identifying conditions of our instrument are met. If the municipalities' use of vocational rehabilitation influences the individual probability of participating in an educational measure, there needs to be variation in how often municipalities apply vocational rehabilitation. Table 1 indicates that this assumption is fulfilled. Moreover, Table 2 indicates that the assumption of the municipalities' use of vocational rehabilitation affecting the individual's chance of participating in education seems to be met. However, we cannot test the assumption that the municipalities' use of vocational rehabilitation does not influence the individual probability of returning to work. This assumption would, for example, break down if municipalities adapt their rehabilitation policy to the labor market situation. If municipalities in areas with a low labor demand often apply vocational rehabilitation, our instrument will be correlated with a covariate that may affect the probability of returning to work. To take this possibility into account, we include the unemployment rate of the local labor market in our estimations.

In addition to the instrumental variables approach, we also use a random effects hazard model to take account of unobserved differences between different groups of injured workers. The random effects model allows different groups of injured workers to have unobserved characteristics that affect the probability both of participating in an educational measure and of returning to ordinary work and subsidized work. We describe the model in detail in section 5.

5. The economic model

To simultaneously model the sick-listed workers' transitions to educational measures and to ordinary work and wage-subsidized work, we use a piecewise constant hazard rate model with random effects. The model has a flexible baseline hazard and a flexible structure of the unobserved heterogeneity (for a discussion of the model, see van den Berg, 2001, and for a similar application of the model, see Høgelund and Holm, 2006). The structure of the unobserved heterogeneity is flexible because the unobserved random effects influencing the three durations (to education, to ordinary work, and to wage-subsidized work) are correlated. Put differently, as the data determines the correlation between the random effects, we do not need to make assumptions about the structure of the relationship between the unobserved effects.

The model consists of three parts, which are conditional on observed covariates. The first part captures the transition into an educational measure:

$$P(D_1(t) = d_1^t) = \frac{\exp\left(\delta_t + \beta_1 x_1 + \varepsilon_1\right)^{d_1^t}}{1 + \exp\left(\delta_t + \beta_1 x_1 + \varepsilon_1\right)} \tag{1}$$

where

t is the time measured in months

$$d_1^t = \begin{cases} 1 & \text{if in education in period } t \\ 0 & \text{otherwise} \end{cases}$$

In addition, x_1 is a vector of covariates influencing the transition into an educational measure, and β_1 is a corresponding row vector of regression coefficients. The parameter δ_t is a time-specific intercept term capturing the duration dependence in the hazard rate into education, and ε_1 is a random variable measuring the effect of unobserved heterogeneity. We assume the unobserved heterogeneity to be independent of observed covariates and constant over time. We also assume that conditional on entering education the completion of education is exogenous. The completion of education is indicated by:

$$d_2^t = \begin{cases} 1 & \text{if education is completed before period } t \\ 0 & \text{otherwise.} \end{cases}$$

The second part models the transition to ordinary work and to wage-subsidized work:

$$P(D_3(t) = j) = \frac{\exp\left(\delta_{21t} + \gamma_{11} d_1^t + \gamma_{12} d_2^t + \beta_{21} x_{21} + \varepsilon_{21}\right)^{d_{31}(t)} \cdot \exp\left(\delta_{22t} + \gamma_{21} d_1^t + \gamma_{22} d_2^t + \beta_{22} x_{22} + \varepsilon_{22}\right)^{d_{32}(t)}}{1 + \exp\left(\delta_{21t} + \gamma_{11} d_1^t + \gamma_{12} d_2^t + \beta_{21} x_{21} + \varepsilon_{21}\right) + \exp\left(\delta_{22t} + \gamma_{21} d_1^t + \gamma_{22} d_2^t + \beta_{22} x_{22} + \varepsilon_{22}\right)}; \; j = 0,1,2 \tag{2}$$

where

$$j = 1 \Leftrightarrow d_{31}^{t} = \begin{cases} 1 & \text{if returning to ordinary work in period } t \\ 0 & \text{otherwise.} \end{cases}$$

$$j = 2 \Leftrightarrow d_{32}^{t} = \begin{cases} 1 & \text{if returning to wage-subsidized work in period } t \\ 0 & \text{otherwise.} \end{cases}$$

and x_{21}, x_{22} are observed covariates with β_{21}, β_{22} as the two corresponding row vectors of regression coefficients. The coefficients γ_{j1} and γ_{j2}, $j = 1, 2$ measure the effect of entering and completing an educational measure on the hazard rates to ordinary work and wage-subsidized work. The coefficients $\varepsilon_{21}, \varepsilon_{22}$ measure the unobserved effects in the hazard rate to ordinary work and wage-subsidized work.

The model's third part comprises the density of the unobserved effects denoted $\varphi(\boldsymbol{\varepsilon}); \boldsymbol{\varepsilon} = \varepsilon_1, \varepsilon_{21}, \varepsilon_{22}$. By choosing an appropriate multivariate density, the random effects can be correlated.

Denoting the discrete duration until returning to work or censoring as T_i, we calculate the individual contribution to the log-likelihood function:

$$\ln L_i = \ln \left[\varphi(\boldsymbol{\varepsilon}) \prod_{t=1}^{T_i} P(D_1(t) = d_1)^{1-d_2^t} \times P(D_2(t) = j) \right] \quad (3)$$

In principle, (3) is a mixture model with a logit model of entering an educational measure and a multinomial model of returning to ordinary work or wage-subsidized work, where $\gamma_{11}, \gamma_{12}, \gamma_{21}$ and γ_{22} measures the effect of participating in an educational measure on the transitions to ordinary work and to wage-subsidized work. To estimate the model, we integrate out the distribution of the random effects. Following Heckman and Singer (1984), we approximate the unknown distribution of random effects by a discrete distribution with a finite number of mass points.

6. Findings

Table 2 shows the estimation results of the random effects hazard rate model. The estimations of the hazard rate to educational measures, returning to ordinary work, and returning to wage-subsidized work are estimated simultaneously. Furthermore, table A.2 in the Appendix shows the estimation results of a similar model without random effects and table A.3. in the Appendix presents the results of a simpler specification in which the single hazard rate of return to work is estimated, pooling together return to ordinary employment and wage-subsidized employment .

Table 2. Random effects hazard rate model of participation in an educational measure and returning to ordinary work and wage-subsidized work (n=1,620).

	Participation in an educational measure		Returning to ordinary work		Returning to wage-subsidized work	
Municipalities' vocational rehabilitation tendency	0.151	0.032***	-	-	-	-
Enrollment in an educational measure (yes=1)	-	-	0.066	0.327	-0.363	0.388
Completed an educational measure (yes=1)	-	-	0.425	0.222*	0.587	0.201***
Female (yes=1)	-0.106	0.089	-0.170	0.105	-0.376	0.164**
Age	-0.064	0.004***	-0.012	0.004***	-0.015	0.006**
Ethnic background (other than Danish=1)	-0.622	0.152***	-0.405	0.220*	-0.372	0.318
Cohabitation status (Living with spouse=1)	0.697	0.078***	-0.145	0.091	0.236	0.150
Educational attainment						
Vocational education	0.574	0.083***	0.342	0.101***	0.362	0.143**
Short higher education[1)]	1.319	0.094***	0.409	0.129***	0.378	0.197*
Medium-long and long higher education	0.440	0.103***	0.596	0.126***	-0.084	0.226
Seniority (number of months) [2)]	0.113	0.055**	0.083	0.043*	0.014	0.069
Seniority information missing (yes=1)	-2.421	0.284***	-0.297	0.242	-0.904	0.421**
Injured part of the body						
Back	-0.632	0.115***	-0.127	0.130	-0.579	0.187***
Body	-0.561	0.255**	-0.490	0.237**	-0.951	0.369**
Upper extremity	-0.112	0.118	-0.039	0.135	-0.341	0.192**
Lower extremity	-0.215	0.130*	0.047	0.144	-0.457	0.214**
Multiple or general injuries	-0.051	0.160	-0.500	0.200**	-0.719	0.276***
No information on injured part of body	-0.264	0.425	0.982	0.518*	-0.524	0.771
Type of injury						
Wound etc.	0.147	0.103	0.249	0.138*	0.024	0.205
Strain and slipped disc	-0.308	0.092***	-0.090	0.115	-0.279	0.171
Unknown injury type	-0.951	0.215***	-0.488	0.300	0.404	0.298
Industrial branch (of injury company)						
Production	-0.571	0.120***	-0.004	0.172	-0.002	0.238
Construction	0.397	0.118***	-0.038	0.157	-0.065	0.223
Trade, hotel, banking, real estate	-0.289	0.136**	0.153	0.177	-0.068	0.266

Transportation	0.470	0.154***	0.086	0.164	-0.245	0.249
Public administration, education	0.708	0.160***	0.080	0.194	-0.219	0.322
Health and social services	0.272	0.125**	-0.077	0.178	-0.247	0.267
Information on industrial branch missing	-1.072	0.176***	0.139	0.190	-0.164	0.293
Company size[2)]	0.022	0.007***	-0.005	0.008	0.009	0.010
Unemployment level	0.061	0.020***	0.010	0.022	-0.007	0.037
Baseline, 7-24 months	2.641	0.164***	-1.565	0.090***	-0.049	0.165
Baseline, 25-48 months	3.456	0.165***	-2.948	0.157***	-0.268	0.178
Baseline, 49-72 months	2.620	0.171***	-3.104	0.213***	-0.778	0.228***
Baseline, 73 months and more	1.890	0.211***	-4.225	0.582***	-1.514	0.434***
Constant	-2.000	0.281***	-2.877	0.356***	-4.031	0.508***
Random effects	-5.049	0.087***	0.421	0.253*	0.242	0.248
Fraction of observations with random effects	0.880		0.880		0.880	

Note: the hazard rate models are estimated simultaneously. Standard errors between brackets. Significance levels: *** significant at 1%, ** significant at 5%, * significant at 10%.

1): Including certain vocational educations.

2): Multiplied by 100.

Our instrument, the municipalities' use of vocational rehabilitation, behaves as expected. The coefficient is positive, meaning that injured workers from municipalities that often use vocational rehabilitation have a higher probability of participating in an educational measure than injured workers from municipalities with a more restrictive vocational rehabilitation policy. The covariate is highly significant with a p-value of 0,000. Furthermore, the instrument appears to be robust to bias arising from individual unobserved heterogeneity as the magnitude of the coefficient and the standard errors are very similar in the model with and without random effects.

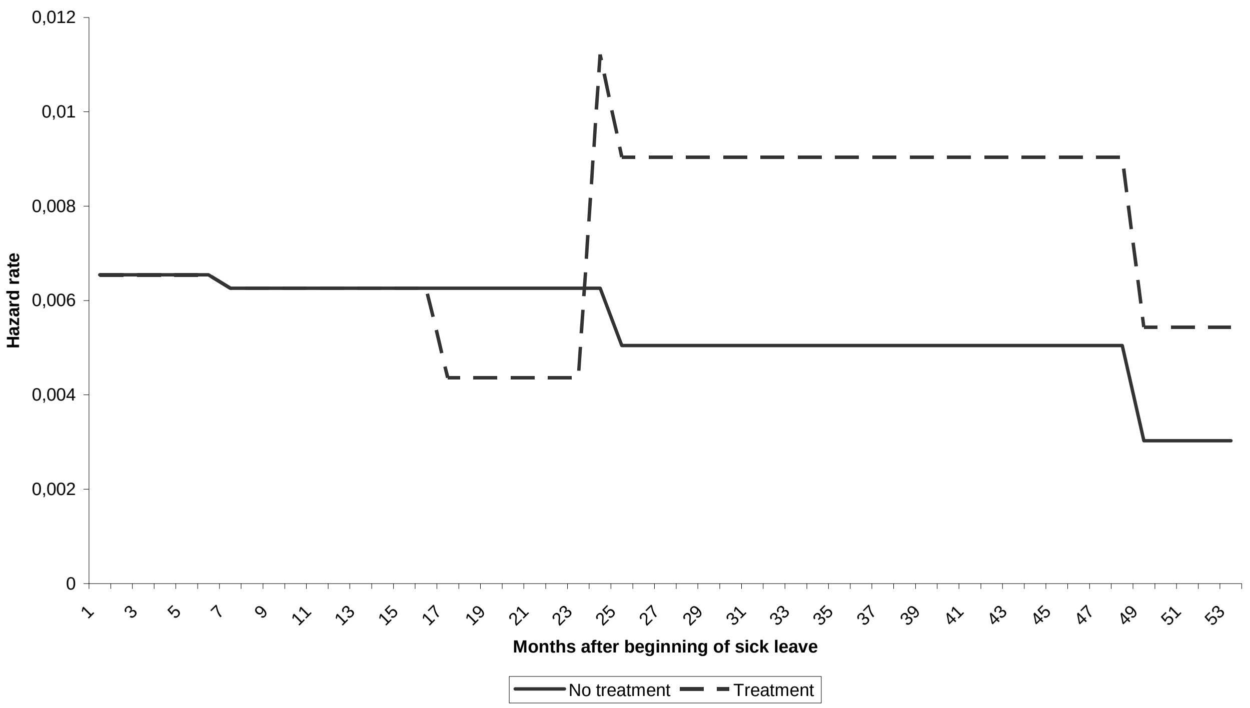
Several factors affect the selection to educational measures. We see that age, ethnic background, cohabitation status, educational background, type of injury, injured part of the body, and industrial sector of the injured worker's firm influences the probability of participating in education. The probability of participating in an educational measure is relatively low for injured workers who are old, who are low-educated, who have an ethnic background other than Danish, who are injured in their back or elsewhere in their body, and who suffer from strain or a slipped disc. In addition, the chance of participating in education increases when the regional unemployment rate is high and when the place of work where the injury takes place is situated in the public sector (public administration, education, health and social services) or in the transportation sector.

The selection to education is highly influenced by unobserved factors. The random effects component suggests that a group of injured workers have characteristics that significantly reduce their chance of participating in an educational measure. In addition, several of the coefficients of the observed covariates change sign or magnitude when we add random effects to the model (see appendix Table A.2). For example, in the model without random effects, the unemployment rate is negative and highly significant, while it becomes positive and highly significant in the model with random effects.

Educational measures have a positive effect on the injured workers' probability of returning to work, especially to wage-subsidized work. In the equation for wage-subsidized work, the coefficient of the covariate that measures the effect of having terminated an educational measure is 0.587, with a p-value of 0.003. At the same time the analysis suggests that the lock-in effect of being enrolled in an educational measure is insignificant (p-value of 0.388), with a coefficient of -0.363.

Figures 3 and 4 illustrate how participation in an educational measure affects the probability of returning to wage-subsidized work.

Figure 3: Illustration of treatment effect (return to subsidised work)



In Figure 3, the solid line depicts an average injured worker, i.e. all covariates are set equal to their mean, who does not participate in education. The dot-and-dashed line shows an average injured worker who starts in an educational measure 17 months after the first day of sick leave and participates in the measure for seven months.[11] Whereas the probability of returning to wage-subsidized work decreases during enrollment in the measure (the insignificant lock-in the effect), the probability significantly increases when the measure is terminated.

Figure 4: Illustration of survival curves (return to wage-subsidised work)

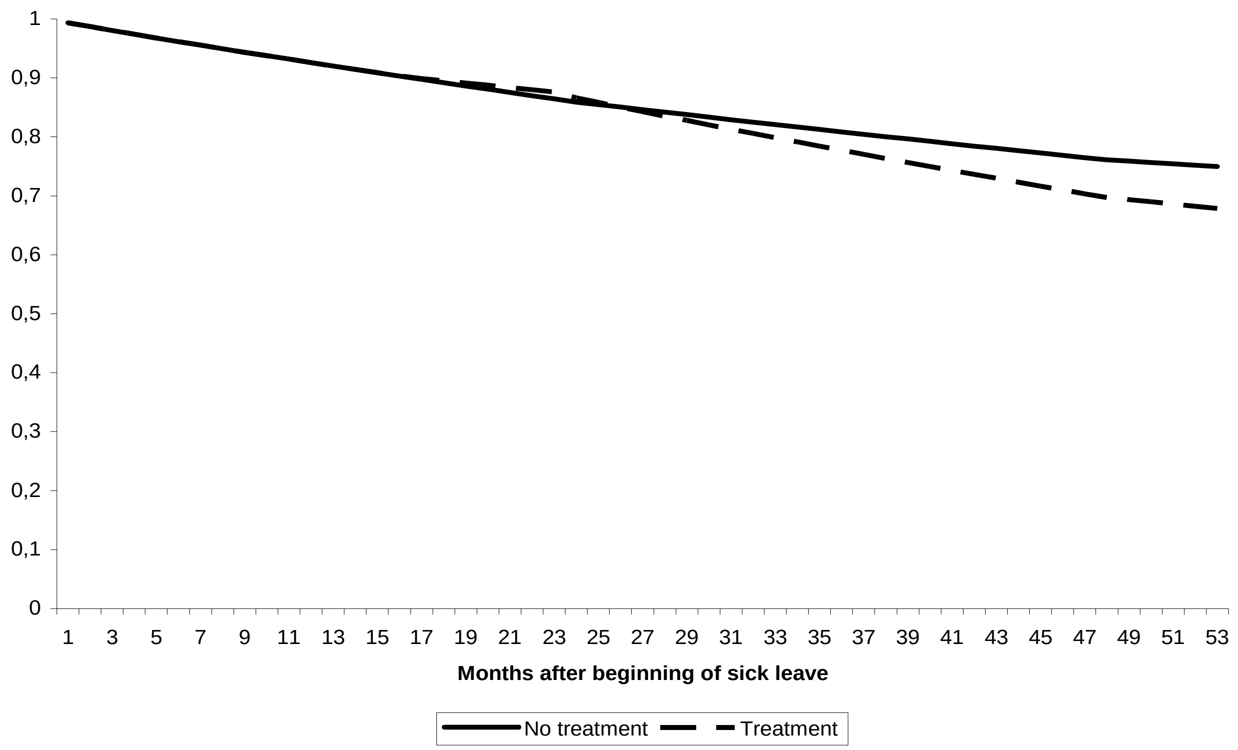


Figure 4 shows the survival curves of an average injured worker with and without treatment. Twenty-seven months after the beginning of the sick leave, the positive treatment effect starts to dominate the negative lock-in effect, i.e. at this time the percentage of treated individuals who returned to work (15.7 percent) exceeds the percentage among non-treated individuals (15.4 percent). One year later the magnitude of the positive treatment effect has increased, i.e. 24.4 percent of the treated injured workers returned to work compared to 20.4 percent among the non-treated workers.

The effect of educational measures on the probability of returning to ordinary work is smaller than the effect of educational measures on the probability of returning to wage-subsidized work. The coefficient to ordinary work is 0.425, with a p-value of 0.056. Again, the analysis shows that there is no significant lock-in effect of participating in an educational measure. These effects are illustrated in Figures 5 and 6.

[11] Here we are using median values instead of the means, because the distributions are right skewed. This problem is especially true for the duration of educational measures, where the mean is 14 months and the median is seven months.

Figure 5: Illustration of treatment effect (return to ordinary work)

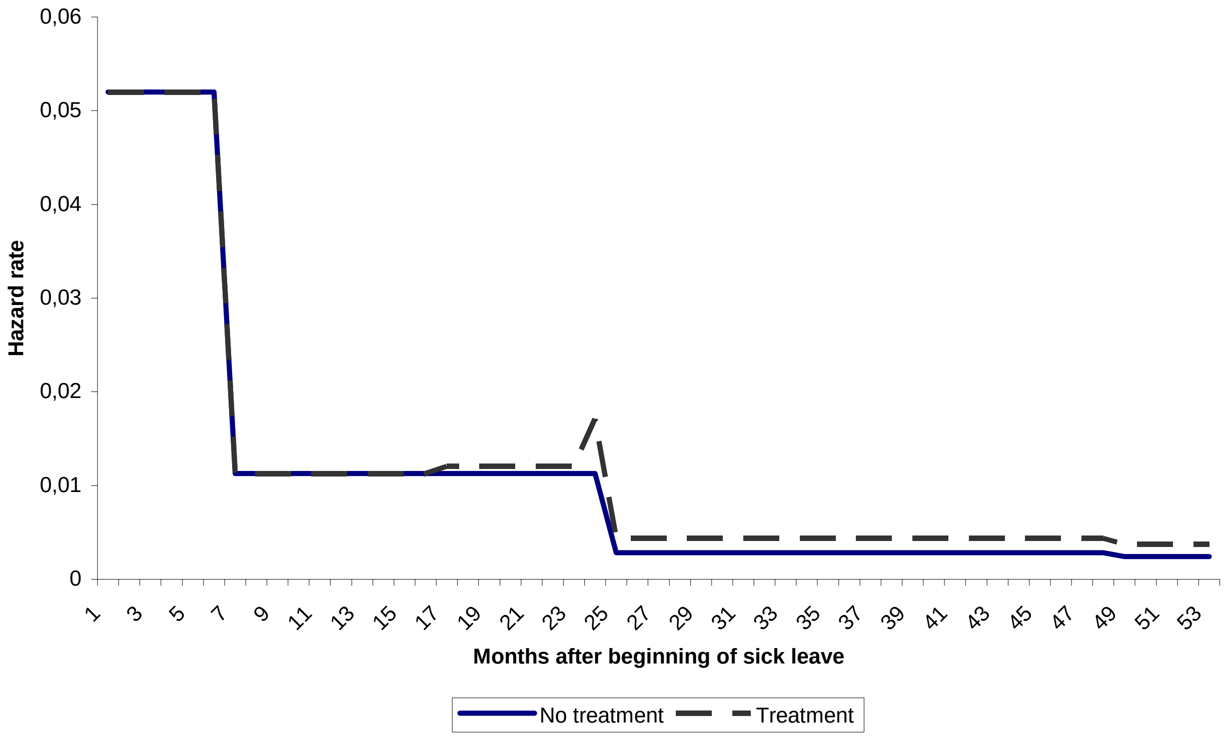
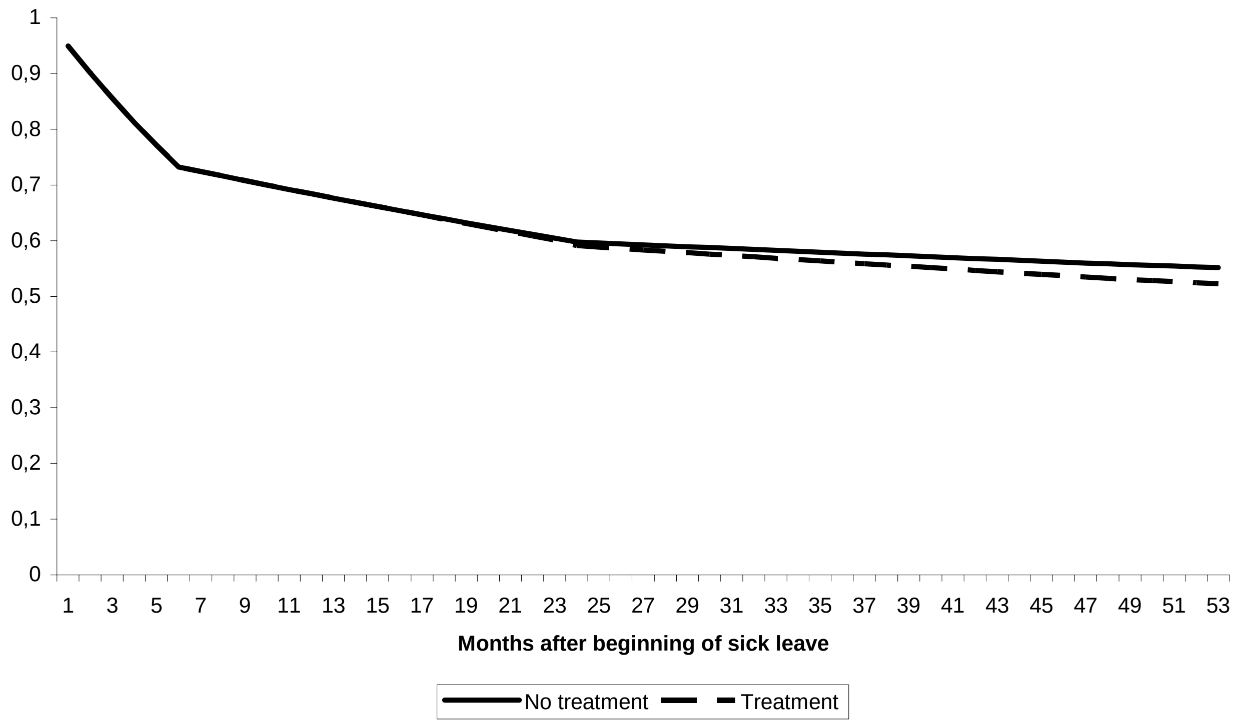


Figure 6: Illustration of survival curves (return to ordinay work)



From Figure 5, we see that the insignificant effect of being enrolled in a measure is slightly positive, meaning that the positive effect of participating in an educational measure starts to take effect relatively early in the sickness spell, in this case 17 months after the beginning of the sick leave. Comparing Figure 6 with Figure 4, we see that educational measures have a much smaller effect on the probability of returning to ordinary work than it has on the probability of returning to wage-subsidized work. For example, forty months after the beginning of the sick leave the fraction of treated individuals who returned to ordinary work is only 5 percent bigger than the fraction among non-treated individuals, whereas this difference is 21 percent with respect to wage-subsidized work. One explanation for this finding could be that sheltered working conditions accommodate disabilities and thereby allow returning workers to best apply their newly acquired skills. An alternative and more likely explanation is that employers always have an incentive to hire disabled workers for whom they receive wage subsidies.

A comparison of the model with random effects (Table 2) to the model without random effects (appendix Table A.2) underlines the importance of taking unobserved heterogeneity into account. The estimated employment effect is smaller in the model without correction for unobserved covariates than in the model with correction for unobservables. More precisely, the model without random effects tends to underestimate the effect of having completed an educational measure while overestimating the lock-in effect. Correcting for unobserved heterogeneity moves some of the other parameters as well. In the participation equation, for example, the indicators for the injured part of body and some of the industry affiliation indicators change signs and significances. The estimated parameters in the each of the return-to-work hazards, however, remain largely the same.

Several other covariates affect the probability of returning to work. Age, educational background, ethnic background, and injured part of the body influence the probability of returning to ordinary work. In particular, having injuries to the body and sustaining multiple injuries significantly reduce the chances of returning to work. To some extent the same covariates affect the probability of returning to wage-subsidized work. That is, age, educational background and injured part of the body also influence the probability of returning to wage-subsidized work. For both types of employment, skilled workers are also more likely to return to work. In addition to these covariates, sex and cohabitation status are also of importance for the probability of returning to wage-subsidized work.

Our approach, which allows education to have diverse effects on the probability of returning to ordinary work and wage-subsidized work appears to be fruitful. Thus, a comparison of the model that allows education to have diverse effects (Table 2) and a simple return-to-work model, pooling together return to ordinary work and wage-subsidized work (appendix Table A.3), suggests that the latter model underestimates the educational effect on wage-subsidized work. This problem arises because the relatively limited positive effect on ordinary work dominates the effect on wage-subsidized work.

7. Conclusions

Existing studies on the employment effects of vocational rehabilitation for work-injured people are hampered by a lack of good comparison groups and convincing instrumental variables. Using data on about 1,620 work injured persons, we simultaneously estimated the hazard rate to educational measures and the return to work, distinguishing between ordinary employment, and wage-subsidized employment. Thus, our framework allowed the effect of vocational rehabilitation through education to have varying “treatment” effects, depending on the conditions of the post-injury job and/or the hiring incentives to employers. To correct for unobserved heterogeneity we used a random effects model and the instrumental variables approach. As an instrument we used the municipalities’ use of vocational rehabilitation, assuming that the individual probability of participating in an educational measure is correlated positively with the municipalities’ use of vocational rehabilitation.

The analysis showed that injured workers’ participation in education significantly increased their chances of returning to work. The effect to wage-subsidized employment was bigger and more significant than the effect to ordinary employment, suggesting that the weak effect of educational measures found in previous studies resulted from a failure to distinguish between return to ordinary work and return to wage-subsidized work. The analysis supports, therefore, more than the existence of a human capital effect of educational measures, it also demonstrates that educational measures are most effective in returning sick-listed workers to wage-subsidized employment. Either sheltered working conditions allow workers to best apply their newly acquired skills by providing a setting that minimizes the impact of their injury or, and perhaps more likely, employers have an added incentive to hire disabled workers when they can partially defray their wages through government subsidies.

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Appendix

Table A.1. Mean, standard deviation and deciles for unemployment covariate.

	Mean	Std.dev	10% decile	90% decile	N[1)]
Unemployment rate, 1-6 months	6.648	1.940	4.250	9.150	1,620
Unemployment rate, 7-12 months	6.349	1.732	4.200	8.850	1,620
Unemployment rate, 13-18 months	6.038	1.588	4.100	7.950	1,620
Unemployment rate, 19-24 months	5.893	1.453	4.075	7.750	1,620
Unemployment rate, 25-30 months	5.711	1.352	3.900	7.450	1,620
Unemployment rate, 31-36 months	5.714	1.288	4.000	7.300	1,620
Unemployment rate, 37-42 months	5.687	1.295	3.950	7.150	1,617
Unemployment rate, 43-48 months	5.811	1.292	4.100	7.350	1,605
Unemployment rate, 49-54 months	5.839	1.326	4.150	7.350	1,552
Unemployment rate, 55-60 months	5.960	1.303	4.250	7.400	1,469
Unemployment rate, 60-66 months	5.992	1.368	4.250	7.700	1,309
Unemployment rate, 67-72 months	6.059	1.320	4.400	7.700	1,157
Unemployment rate, 73-78 months	6.068	1.372	4.400	7.600	947
Unemployment rate, 79-84 months	6.240	1.350	4.550	7.900	759
Unemployment rate, 85-90 months	6.260	1.389	4.450	8.050	596
Unemployment rate, 91-96 months	6.493	1.354	4.800	8.300	473
Unemployment rate, 97-102 months	6.454	1.398	4.800	8.300	320
Unemployment rate, 103-108 months	6.423	1.264	4.800	8.300	227
Unemployment rate, 108-114 months	6.308	1.262	4.700	8.300	117
Unemployment rate, 114-120 months	6.202	1.174	5.000	8.700	47

The unemployment rate is measured relatively to the beginning of the sick leave period.

1): Note that the number of observations is negatively correlated with the number of months, because many of the injured workers have relatively short return to work spells, meaning that these workers are not included in the calculations of unemployment rates for long durations.

Table A.2. Hazard rate model of participation in an educational measure and returning to ordinary work and wage-subsidized work (n=1,620).

	Participation in an educational measure		Returning to ordinary work		Returning to wage-subsidized work	
Municipalities' vocational rehabilitation tendency	0.145	0.022***	-	-	-	-
Enrollment in an educational measure (yes=1)	-	-	-0.249	0.268	-0.564	0.330*
Completed an educational measure (yes=1)	-	-	0.311	0.214	0.511	0.187***
Female (yes=1)	-0.219	0.058***	-0.177	0.105*	-0.375	0.164**
Age	-0.086	0.002***	-0.011	0.004**	-0.014	0.006**
Ethnic background (other than Danish=1)	-0.599	0.124***	-0.395	0.220*	-0.372	0.317
Cohabitation status (Living with spouse=1)	-0.035	0.049	-0.125	0.090	0.250	0.150*
Educational attainment						
Vocational education	0.860	0.060***	0.340	0.101***	0.359	0.143**
Short higher education[1)]	1.257	0.067***	0.407	0.129***	0.377	0.197*
Medium-long and long higher education	0.868	0.075***	0.587	0.126***	-0.089	0.226
Seniority (number of months) [2)]	-0.036	0.031***	0.088	0.043*	0.017	0.069
Seniority information missing (yes=1)	-1.809	0.248***	-0.304	0.242	-0.923	0.420**
Injured part of the body						
Back	0.429	0.081***	-0.149	0.129	-0.595	0.187***
Body	0.225	0.135*	-0.509	0.236**	-0.957	0.369**
Upper extremity	0.330	0.087***	-0.048	0.135	-0.351	0.191*
Lower extremity	0.852	0.088***	0.019	0.143	-0.476	0.213**
Multiple or general injuries	0.340	0.113	-0.501	0.200**	-0.712	0.275**
No information on injured part of body	0.874	0.383	0.911	0.516*	-0.574	0.769
Type of injury						
Wound etc.	0.005	0.078	0.245	0.137*	0.023	0.205
Strain and slipped disc	-0.316	0.064***	-0.095	0.115	-0.283	0.171*
Unknown injury type	-0.989	0.173***	-0.496	0.300*	0.395	0.298
Industrial branch (of injury company)						
Production	0.249	0.089***	-0.028	0.171	-0.018	0.237
Construction	-0.115	0.086	-0.031	0.156	-0.053	0.222
Trade, hotel, banking, real estate	-0.040	0.105	0.153	0.177	-0.070	0.266
Transportation	-0.355	0.108***	0.109	0.164	-0.229	0.248
Public administration, education	0.230	0.105**	0.102	0.194	-0.203	0.322
Health and social services	0.370	0.091***	-0.068	0.177	-0.240	0.267
Information on industrial branch missing	-0.973	0.149***	0.141	0.190	-0.166	0.293
Company size[2)]	0.024	0.004***	-0.005	0.008	0.009	0.010

Unemployment level	-0.073	0.015***	0.013	0.022	-0.004	0.037
Baseline, 7-24 months	2.301	0.152***	-1.553	0.090***	-0.041	0.165
Baseline, 25-48 months	2.820	0.151***	-2.920	0.157***	-0.246	0.177
Baseline, 49-72 months	2.289	0.155***	-3.082	0.213***	-0.760	0.228***
Baseline, 73 months and more	1.385	0.188***	-4.200	0.582***	-1.498	0.434***
Constant	-2.360	0.226***	-2.583	0.302***	-3.857	0.473***

Note: the hazard rate models are estimated simultaneously. Standard errors between brackets. Significance levels: *** significant at 1%, ** significant at 5%, * significant at 10%.

1): Including certain vocational educations.

2): Multiplied by 100