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Transitions to disability and rehabilitation

Abstract:
The discrete choice model of McFadden (1973) is used to quantify the desire for going into rehabilitation or disability among fully employed married women in Norway. Predictions using the model indicate that as much as 60 percent of full-time employed married women going into disability or rehabilitation are not doing so entirely voluntarily. Using a set of identifying assumptions we decompose transitions into different components. Important findings are that decreasing unemployment has also played a significant role in increasing the number on disability and rehabilitation, while changes in disability benefits have not played a large role.

Keywords: social security, disability, rehabilitation, discrete choice

JEL classification: C35, H55, I12, I18

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1. Introduction

OECD (2006, 2007) note that in most industrialized countries average health status has been improving, yet more and more people of working-age leave the workforce and rely on health-related income support. In Norway the number of disability insurance recipients per adult ages 25-64 went from 5.5 percent in 1967 to 8.2 percent in 1980 and 12.4 percent in 2004. In trying to stop or even reverse this trend, there has been much focus on changing the incentives faced by workers. Tightening the incentive structure seems appropriate if lax regulations and less stringent work norms have led to an increasing number of workers voluntarily leaving the workforce for disability. On the other hand, if it is increasing pressure on the workers which has been pushing workers with reduced work capacity out of the work force, then such tightening might not be that appropriate. In this case a minority of workers with reduced capacity are being squeezed out of the work force by demands for increased productivity, even while this increased productivity benefits the majority of workers delivering higher wages and, arguably, more interesting jobs. If access to disability benefit is reduced, workers experiencing difficulty in keeping up at work must find alternative work reflecting their productivity, but this can be difficult because of the presence of unions and other institutions and regulations influencing minimum wages. As an alternative they may be forced to seek unemployment or general social security benefits.

The aim of this paper is to give an indication of the degree to which the increase in disability in Norway in the 90s is the result of firms pushing workers onto disability benefit. We consider a transition to disability as *voluntary* if the worker thinks her work is deemed satisfactory, but she experiences higher utility being disabled than working. A transition is considered *involuntary* if the feeling of not being able to deliver satisfactory work leads the worker to seek disability.

Disentangling the desire of the workers to stay in their job from the desire of the firms to keep the workers employed is difficult. Any comprehensive indictors of these desires will necessarily be rough and based on strong assumptions. The central element in our paper is the prediction of the individuals' probability of wishing voluntarily to go to disability or rehabilitation. This prediction is based on McFadden's (1973) discrete choice model and the use of the well-known independence of irrelevant alternatives (IIA) property of the discrete choice model. From this prediction we can infer the probability of making such a transition involuntarily, and under certain assumptions, characterize the probabilities of firms wishing to get rid of a worker and the government accepting a person on social security.

We assume that the difference between the predicted probabilities of workers desiring social security and the observed transitions is due to the firms' behavior and government implementation of the rules governing disability and rehabilitation. We develop two measures quantifying how many workers are involuntarily pushed onto social security by conditions at work. One is a simple residual, assuming that the difference between the observed probability of going onto social security and the predicted probability of workers wishing voluntarily to go to social security measures the number of workers being pushed involuntarily onto social security. The other is based on the use of a set of identifying assumptions to find the probability of the firms wishing for workers to enter social security and the probability that the government will accept workers onto social security. It entails a sequential estimation approach, with each step being conditional on the estimates of the preceding one.

Our study focuses on married females working full time during the period 1992 to 1998, with separate analyses of each of the six age groups 35-39, 40-44, 45-49, 50-54, 55-59 and 60-64. The number of married female workers making the transition to disability or rehabilitation is 24,004, giving us an average yearly transition rate from full-time employment to rehabilitation or disability of 1,8 percent. Two thirds of these transitions are to rehabilitation, while the remaining third goes directly to disability.

Our primary finding is that there are indications that involuntary transitions have been increasing over the time period we consider, even when controlling for changes in sick leave and taking explicit account of the possibility that individuals might take advantage of the increased availability and generosity of the social security system to gain leisure time. Involuntary transitions may have increased because work conditions may have become more physically or psychologically challenging for some groups. For example Røed and Fevang (2005) find that reorganization in the private and public sector can lead to increased sick leave. There might also be less flexibility in some work places, so there is less chance that jobs can be adjusted to accommodate workers with impairments. Increases in labor force participation may also have drawn workers with more health problems into the workforce.

Using the identifying assumptions we can decompose changes in the observed transitions to disability and rehabilitation into different components. An increased number of women on sick leave explains about half the increase in the number of transitions. Changes in the number of full-time employed in the different age groups account for about a third, while changes in benefits levels only account for around 4 percent of the increase. Other changes in the composition of married women, such as for example changes in education and work sector, serve to decrease the number making a transition to social security. Decreasing unemployment has also played a significant role in increasing the number on disability and rehabilitation. Our results are in accordance with other Norwegian studies, such as Bratberg (1999) and Andreassen and Kornstad (2006), in finding that economic incentives play a role (but a lesser role than implied in these papers), while also finding support of the results of Haveman et al. (1991) that other factors are more important.

Our approach is unusual and as far as we know new to the field. We attempt to extract the behavior of firms, workers and the government only from observed transitions and the use of theoretical considerations. The survey articles of Bound and Burkhauser (1999) and Haveman and Wolfe (2000), indicate that most studies of transitions into disability emphasize the choices of the individuals and to some extent the workings of the social security system, while little has been done on the behavior of the firms. An exception is Danzon (1993), who - in discussing public disability insurance in the U.S. - emphasizes the effect of the firm as a potential insurer of the workers.

While there are common trends that most OECD countries share, there are also large differences in how the different social security systems work, so the conclusions of many articles do not easily generalize from one nation to another. Examples of analyses of different pension systems are Anderson et al. (1999), who analyze the effect of changes in pension plans and social security on the retirement of men in the United States, Andrén (2008), who analyzes exits from the Swedish labor market using a competing risks model, and Harkness (1993) who measures the impact of disability benefits on the work choice of disabled males in Canada.

We do not explicitly model the application process, instead we use an indirect method to find the probability of the government accepting workers onto social security. In contrast, Halpern and Hausman (1986) take explicitly into consideration the application process in their econometric model of disability, while Silva and Windmeijer (2001) develop an econometric model that makes it possible to separately identify the parameters driving the decisions of the individual and the health care provider. Hu et al. (2001) estimate a multistage logit model reflecting the disability determination process in the U.S.

2. Background and data

In 1936 the first general public disability insurance law was introduced in Norway, giving assistance to the blind and very heavily disabled. A more comprehensive public disability insurance was introduced in 1961, and in 1967 this became part of the newly established public social security system called "Folketrygden", which remains the bedrock of Norwegian social security. Today, all Norwegians, including non-workers, are eligible for disability and rehabilitation pensions.

Initially, the criteria for receiving a disability pension were strict. Over time what was considered a serious medical condition expanded. For example, from 1976 alcoholism was recognized as a disease giving the right to a disability pension. A large increase in the number of disabled in the 80s led to a series of reforms at the beginning of the 90s, based on a consensus that the increase was due to laxer criteria for becoming disabled. Reforms enacted in 1991 required that a more rigorous connection between a medical illness and work ability had to be shown. There was also an attempt to restrict the types of "non-objective" illnesses, but this was abandoned in 1995. In 1992, there was a reduction in the pensions received by the disabled, and in 1998 it became more difficult to be declared disabled at a young age.

In 2000 a general rule was established requiring that rehabilitation must be attempted before a disability pension could be given. In a further attempt to avoid people ending up in a state of permanent disability, in 2004 a temporary disability pension was introduced. This implies receiving a disability pension for a limited time period, after which the disability must be reevaluated (about 40% of new pensioners today receive such a time-limited disability pension). A more detailed discussion of the main developments in the Norwegian public disability system can be found in NOU (2007), a report from a government appointed commission.

Our data are taken from the event data base FD-Trygd, developed by Statistics Norway. These data cover demographic events, education, incomes, transitions in the labor market and social security information for the whole Norwegian population from 1992. For each year we observe the transitions between six states from the end of the year to the end of the next. We distinguish between the following states: Employed (E), Part-time (P), Student, self-employed or unemployed (S), Disabled (D), Rehabilitation (R) and Other (O). Thus, the state (S) contains persons who are not ordinary wage earners, but have a labor market connection. We define individuals as disabled or on rehabilitation if they have a disability degree of 50 percent or more. The analysis assumes that all observations in each year are treated as independent observations. Only married females working full-time (more than 30 hours per week) are included in the study.

Table 1. The number of transitions from full-time work. Married women 1992-1998*

	Age group						
	35-39	40-44	45-49	50-54	55-59	60-64	Total
E. Employed full-time	222,299	268,195	284,405	223,342	127,030	56,119	1,181,390
P. Part-time	14,899	13,701	11,523	8,282	4,676	2,281	55,362
S. Student / Self-emp. / Unemp.	11,671	12,750	10,736	6,364	2,920	1,439	45,880
R. Rehabilitation	2,696	3,174	3,649	3,227	1,744	617	15,107
D. Disability	263	508	1,039	1,684	2,346	2,957	8,797
O. Other	9,162	5,167	4,247	3,253	2,350	2,547	26,726
Total	260,990	303,495	315,599	246,152	141,066	65,960	1,333,262

Women that died during the period or went abroad are excluded from the table.

The distribution over the states and the relative number making different transitions out of full-time employment are given in Table 1. Note that from one year to the end of the next, more women under 55 years go to rehabilitation than to disability, while the opposite is true for those 55 years or older. We have not defined sick leave as a separate state. Instead it is used as an explanatory variable, because it is a transitory state with limits on how long one can stay in the state. In addition, most workers receive full income compensation from the first day of sick leave, so there are no financial disincentives in going on sick leave.

The six age groups 35-39, 40-44, 45-49, 50-54, 55-59 and 60-64 are studied separately, giving us six fairly homogeneous groups totaling slightly more than 1.3 million instances of full-time work from 1992 to 1998. The number of married female workers making the transition to disability or rehabilitation is 24,004, giving us an average yearly transition rate from full-time employment to rehabilitation or disability of 1.8 percent. Two thirds of these transitions are to rehabilitation, while the remaining third goes directly to disability. Our results regarding the age group 60-64 are less reliable than those for the other age groups because at this age behavior is affected by the Norwegian early retirement program "AFP", affecting individuals from the age of 63 from 1997 and from the age of 62 from 1998. We do not take this program into account in our analysis. See Bratberg et al. (2004) for an analysis of this program.

Only sick leave financed by the social security system, not including the first 14 days of sick leave paid by the employer, is included in the data. Information about sick leave is collected from registers administered by the Social security administration (Rikstrygdeverket/NAV). They include information on the prognosis given by the medical doctor treating the patient. On the basis of this, we have defined four dummy variables for sick leave: 1) A “good prognosis” defined as: “Medical treatment alone is assumed to make the patient fully able to work” (the wording in the form filled in by the medical doctor), 2) A “bad prognosis” comprising all other prognoses, and 3) “No prognosis”, if a patient for some reason does not have any prognosis at all. For those with a “good prognosis” we distinguish between those with a short period (less that 60 days) and a long period on sick leave (more than 59 days[1]). If the person has been on several sick leaves during the year, it is the most recent leave that counts.

Transitions are affected by expected incomes in the different states. Full-time wage income is set equal to the observed income of everybody in the initial state (adjusted for inflation using the consumer price index), while the incomes in the other states are predicted on the basis of income regressions using data on the rest of the population found in FD-Trygd.

Predictions of disability pension income are based on three separate estimations for pensioners with a degree of disability of 50-67 percent, 68-83 percent and 84-100 percent, respectively, while predictions of rehabilitation income are based on separate estimations for three different categories of rehabilitation. Non-labor incomes are equal across states and include child benefits, child care allowance and rent allowance.

The upper half of Table 2 shows the average income in the different states. It is notable how little variation between different age groups there is in labor incomes, while capital and spousal income vary more. Average labor income falls as the females become older, this might be due to a cohort effect. The lower half of Table 2 shows the average income replacement ratios in the different states. We see that on average a married woman going from full-time employment to rehabilitation would expect to receive between 34 and 37 percent of the income she had when fully employed. If she goes to disability she would expect to receive between 44 and 49 percent of this income.

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[1] For sick leave periods that extends from one year to the next year, we use the total sick leave period.

Table 2. Average income and income replacement ratio (average income divided by average full-time income) in different states. 1000 Norwegian kroner and share of full-time income

	Age group					
	35-39	40-44	45-49	50-54	55-59	60-64
Non-labor income	50	40	34	33	35	39
Income of spouse	318	323	320	307	273	233
Labor income as fully employed	250	250	249	248	242	237
Income replacement ratio (share of full time income)						
- if working part time	0.61	0.62	0.62	0.62	0.60	0.58
- if student or self-employed	0.37	0.33	0.29	0.27	0.25	0.23
- if in rehabilitation	0.37	0.37	0.36	0.36	0.35	0.34
- if disabled	0.49	0.47	0.45	0.45	0.45	0.44
- if other	0.23	0.23	0.21	0.20	0.18	0.15
No. of observations (1,000 persons)	261	303	316	246	141	66

Holen (2007) points out that incomes might not be exogenous. He finds that income in the years preceding a transition to disability tends to rise, possibly because workers are trying to maximize the pension benefits they will receive later.

3. Calculating the probability of the observed transitions

In the following it is being assumed that transitions into disability or rehabilitation (*P*) can be decomposed into a voluntary and an involuntary component according to the following specification:

(1) $$P = P_W Q_W + (1 - P_W) P_F Q_F ,$$

where subscript *W* and *F* refers to workers and firms, respectively. P_W is the probability of workers wishing to voluntarily go to disability or to rehabilitation, while Q_W is the probability that if a worker wishes to go into disability or rehabilitation, he or she will be permitted to do so. Thus, $P_W Q_W$ is the probability that a worker voluntarily makes the transition into disability or rehabilitation. Involuntary transitions into disability or rehabilitation are given by the term $(1 - P_W) P_F Q_F$, where P_F is the probability of the firm wishing to pressure a worker into disability or rehabilitation against his or her will and Q_F is the probability that a firm will be permitted to pressure a worker into disability or rehabilitation. This transition is conditional on the worker not wanting to go voluntarily into rehabilitation or disability (so that $(1- P_W)P_F$ is the unconditional probability).

Our framework necessitates that all variables are expressed as probabilities. In our data we do not observe the probabilities, only the chosen state is being observed. To transform our discrete data to a probabilistic form we predict each individual's probability of going either to disability or rehabilitation based on the estimates we get using a three state (full-time work, disability, rehabilitation) multinomial logit model. In this estimation we apply a reduced form specification using all available explanatory variables, leading to 116 parameter estimates for each age group. On the basis of these estimates we then calculate the predicted probabilities $\hat{P}^D$, $\hat{P}^R$ and $P = \hat{P}^D + \hat{P}^R$ where superscript D and R denote disability and rehabilitation, respectively.

Since this estimation is used only as a kind of an instrument equation, we do not pay much attention to the individual estimates. One reason for not basing our analysis on this direct analysis of the transitions to social security is that it gives us negative income effects, probably due to unobserved heterogeneity of jobs. While the income replacement ratio associated with going onto social security decreases with income, women in high income jobs have higher transition rates to disability and rehabilitation than those in low income jobs.

4. Predicting the desire for disability and rehabilitation

Predictions of the desire for disability (*D*) and rehabilitation (*R*) pension are based on estimation of the transitions between the states Employed (*E*), Part-time (*P*), Student, self-employed or unemployed (*S*) and Others (*O*). Using estimations over the restricted choice set $\{E,P,S,O\}$ to generate predictions for the expanded choice set $\{E,P,S,D,R,O\}$ is possible when the independence from irrelevant alternatives (IIA) assumption applies, as is assumed in the discrete choice model we use.

Let **X** denote a vector of non-labor income variables, **H** a vector of health variables, and **I** a vector of the labor income variables interacted with the demographic dummies. By letting the state specific income variables interact with the demographic variables, we get a richer set of alternative specific variables. Having young children will, for example, influence the degree to which income in a state will affect transitions to this state.

We assume that only income and health enter the utility of the individuals. We choose this parsimonious specification because we wish to avoid having too many individual specific variables, since they are not very suitable for making predictions when new alternatives are introduced. As mentioned, the wage and demographic variables enter as alternative specific variables, while non-labor income and health are the only individual specific variables included. The utility for an individual in state k, u_k, is given as follows

(2) $$u_k = X \cdot \alpha_k^* + H \cdot \beta_k^* + I_k \cdot \gamma + \varepsilon_k, \quad k \in \{E, P, S, O\}$$

(3) $$u_k = X \cdot \alpha_{DR}^* + H \cdot \beta_{DR}^* + I_k \cdot \gamma + \log(\kappa_k) + \varepsilon_k, \quad k \in \{D, R\},$$

where α_k^*, β_k^* and γ are parameter vectors and the ε_k are random terms. Even though we are only concerned with transitions to the combined state of either being on disability pension or in rehabilitation, we need to distinguish between the two in light of our identification procedure discussed later. The κ_k are correction factors for heterogeneity of the combined state of either being in rehabilitation or being disabled (along the lines of McFadden, 1984), and the parameter vectors α_{DR}^* and β_{DR}^* are assumed to be the same for both of these states.

Let y denote the choice of an arbitrary individual i that maximizes utility:

(4) $$y = \arg\max(u_E, u_P, u_S, u_D, u_R, u_O),$$

so that y takes on a value of u_k, $k \in \{E, P, S, D, R, O\}$. As shown in McFadden (1984), if the random terms ε_k are independently distributed with a type I extreme value distribution, i.e., the c.d.f. is

(5) $$F(x) = \exp[-\exp(-x)],$$

then

(6) $$P_W^k = \frac{\exp(X \cdot \alpha_k^* + H \cdot \beta_k^* + I_k \cdot \gamma)}{D_1 + D_2}, \quad k \in \{E, P, S, O\}$$

and

(7) $$P_W^k = \frac{\exp(X \cdot \alpha_{DR}^* + H \cdot \beta_{DR}^* + I_k \cdot \gamma + \log(\kappa_k))}{D_1 + D_2}, \quad k \in \{D, R\},$$

where P_W^k denotes the probability that a full–time worker wishes to go to state k, and where

(8) $$D_1 = \sum_{l \in \{E,P,S,O\}} \exp(X\alpha_l^* + H\beta_l^* + I_l \cdot \gamma)$$

and

(9) $$D_2 = \sum_{l \in \{D,R\}} \exp\left(X\alpha_{DR}^* + H\beta_{DR}^* + I_l \cdot \gamma + \log(\kappa_l) \right).$$

We assume that disability and rehabilitation have equal weights, $\kappa_D = \kappa_R = \frac{1}{2}$, so that

(10) $$P_W = P_W^D + P_W^R = \frac{\exp\left(X \cdot \alpha_{DR}^* + H \cdot \beta_{DR}^* + \log\left(\frac{\exp(I_D \cdot \gamma) + \exp(I_R \cdot \gamma)}{2} \right) \right)}{D_1 + D_2}.$$

Since the IIA property applies, response probabilities for choice in restricted or expanded choice sets are obtained simply by deleting or adding terms in the denominator. Hence we may estimate all the parameters except those in α_{DR}^* and β_{DR}^* by just looking at the subset of transitions going from full-time employment to the states employed (*E*), part-time (*P*), student/self-employed/unemployed (*S*) and others (*O*). Assuming the IIA condition applies, we estimate the four probabilities P_W^E, P_W^P, P_W^S, and P_W^O, given by

(11) $$P_W^k = \frac{\exp\left(X \cdot \alpha_k^* + H \cdot \beta_k^* + I_k \cdot \gamma \right)}{D_1}, \quad k \in \{E, P, S, O\}.$$

We normalize the parameters so that the log-odds ratios can be written

(12) $$\log \frac{P_W^k}{P_W^E} = X \cdot \alpha_k + H \cdot \beta_k + (I_k - I_E)\gamma, \quad k \in \{P, S, O\}.$$

Table 3 reports the estimation results of the transitions from full-time employment to the three states: part-time, student/self-employed/unemployed and others. The estimates are presented as odds ratios, and incomes are in logarithms. Non-significant variables have been eliminated as well as the child variable (saying whether a worker's youngest child is 5 years and younger) for the oldest age group because very few women at this age have so young children. The spouse variables (interacted with income) for the oldest age group were eliminated because their inclusion gave a negative estimate of the income parameter for the wage alone.

Table 3. Odds ratios' parameter estimates for female full-time workers' transitions by age group

		Age group					
		35-39	40-44	45-49	50-54	55-59	60-64
Variables varying with the alternatives							
Wage and pension income							
- if spouse work full-time		1.49	1.92	1.90	1.83	1.11	1.10
		(0.04)	*(0.05)*	*(0.05)*	*(0.06)*	*(0.02)*	*(0.02)*
- if spouse work part-time		1.38	1.67	1.59	1.57		-
		(0.05)	*(0.07)*	*(0.07)*	*(0.08)*		
- if spouse stud. / indep.*		1.17	1.43	1.39	1.29		-
		(0.03)	*(0.04)*	*(0.04)*	*(0.04)*		
- if spouse rehab. / disab.		1.47	1.64	1.75	1.62		-
		(0.06)	*(0.06)*	*(0.06)*	*(0.06)*		
- if spouse other		1.25	1.58	1.58	1.53		-
		(0.04)	*(0.06)*	*(0.06)*	*(0.06)*		
- if youngest child < 6 years		1.06	0.85	0.74	0.53		-
		(0.02)	*(0.02)*	*(0.03)*	*(0.10)*		
- if youngest child 6-17 years		1.34	1.04	0.91	0.87	0.86	
		(0.02)	*(0.02)*	*(0.01)*	*(0.02)*	*(0.03)*	
- if lowest educ. Level		0.87	0.88	0.86	0.87	0.87	0.92
		(0.01)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.02)*
Constant	part-time	0.02	0.03	0.03	0.02	0.02	0.04
		(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
	stud/indep.	0.04	0.03	0.01	0.02	0.01	0.01
		(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
	other	0.02	0.03	0.04	0.03	0.01	0.03
		(0.00)	*(0.00)*	*(0.01)*	*(0.00)*	*(0.00)*	*(0.00)*
Individual specific variables							
Capital income	part-time	1.10	1.05	1.03	1.01	1.03	1.15
		(0.01)	*(0.00)*	*(0.00)*	*(0.01)*	*(0.01)*	*(0.02)*
	stud/indep.	1.08	1.07	1.08	1.07	1.10	
		(0.01)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	
	Others	1.11	1.03			1.04	1.06
		(0.01)	*(0.01)*			*(0.01)*	*(0.01)*
Spouse's income	part-time	1.04	1.03	1.02	1.05	1.04	
		(0.01)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.02)*	
	stud/indep.		1.04	1.08	1.05	1.05	
			(0.01)	*(0.01)*	*(0.01)*	*(0.02)*	
	Others	1.03		0.98			
		(0.01)		*(0.01)*			
Healthy, sick earlier	part-time	1.53	1.60		1.80	1.51	
		(0.16)	*(0.18)*		*(0.23)*	*(0.27)*	
	stud/indep.		1.51				
			(0.8)				
	Others	1.94	1.98	1.49			1.88
		(0.24)	*(0.32)*	*(0.29)*			*(0.44)*
Sick < 60 days	part-time	1.33	1.39	1.31	1.63	1.79	2.36
with good prognosis		*(0.12)*	*(0.14)*	*(0.14)*	*(0.19)*	*(0.26)*	*(0.45)*
	stud/indep.		1.24				
			(0.13)				
	Others	3.23	1.74	2.16	1.86	1.79	1.88

Table 3. Cont.

		Age group					
		35-39	40-44	45-49	50-54	55-59	60-64
		(0.25)	*(0.24)*	*(0.30)*	*(0.31)*	*(0.37)*	*(0.38)*
Sick ≥ 60 days	part-time	1.43	1.68	1.83	2.00	2.85	2.38
		(0.11)	*(0.13)*	*(0.14)*	*(0.17)*	*(0.28)*	*(0.35)*
	stud/indep.	1.30	1.30			1.43	
		(0.12)	*(0.12)*			*(0.24)*	
	Others	3.42	1.86	2.84	2.23	2.59	2.96
		(0.23)	*(0.22)*	*(0.29)*	*(0.27)*	*(0.36)*	*(0.38)*
Sick with no prognosis	part-time		1.51	1.38	1.42	1.84	1.57
			(0.15)	*(0.15)*	*(0.17)*	*(0.26)*	*(0.33)*
	stud/indep.	1.58				1.65	1.64
		(0.16)				*(0.31)*	*(0.42)*
	Others	2.62	2.00	2.07	2.14	2.08	1.70
		(0.24)	*(0.28)*	*(0.31)*	*(0.33)*	*(0.39)*	*(0.33)*
Sick with bad prognosis	part-time	2.15	2.63	2.76	3.38	3.95	3.42
		(0.27)	*(0.27)*	*(0.28*	*(0.33)*	*(0.42)*	*(0.50)*
	stud/indep.	2.03	1.79				
		(0.29)	*(0.23)*				
	Others	2.37	3.26	3.73	4.65	5.26	6.20
		(0.36)	*(0.47)*	*(0.52)*	*(0.61)*	*(0.67)*	*(0.69)*
Number of observations		258,031	299,813	310,911	241,241	136.976	62,386
Number of significant estimates		28	30	25	24	22	17
Log-likelihood		140,967	132,294	116,831	81,684	45,849	26,815
Pseudo R2		0.606	0.682	0.729	0.756	0.759	0.690

Standard errors in parentheses.
Non-significant variables have been dropped. A blank implies the variable is insignificant.
- : implies a variable is dropped for other reasons.
*: Includes student/self-employed/unemployed.

From Table 3 we see that the wage and pension income in a state has a positive effect on the odds ratios. This effect is most pronounced for the age groups 40-44, 45-49 and 50-54. Having a spouse who is not working full-time, increases the effect of the wage income variable for those aged from 35 to 54 years. Having children increases the effect of wage and pension income for younger women, and decreases the effect for older women. Low education decreases the effect of wage and pension income, probably reflecting the fact that those with low education have less flexibility and are therefore more locked into the state of full-time employment. High outside income, either capital or spousal income, will in general increase the probability of a transition out of full-time employment.

Table 3 also shows the effect of the health variables on transitions out of full-time work. We see that all types of long term sick leave imply an increased probability of leaving this state, with the largest effect being on the transition to the state "other". As expected, those with a bad prognosis have a higher probability of going out of the labor force and into the state "others". It is more surprising to see that women in the age group 35-39 with a good prognosis have much larger odds ratio for going to the state “others” than those with a good prognosis in the other age groups. This may indicate that doctors are being too optimistic with regard to the chances of some of these individuals.

In what follow we will use the parameter estimates in Table 3 to make predictions of the probability of voluntarily applying either disability or rehabilitation pension, denoted by $\hat{P}_W$. This can be done by making assumptions about the parameter vectors α^*_{DR} and β^*_{DR} of Eq. 10. We assume that the parameters describing the effect of non-labor income and health on the transition to the state “others” are equal to their effect on the transition to disability and rehabilitation, i.e., $\alpha^*_{DR} = \alpha_o$ and $\beta^*_{DR} = \beta_o$. Then P_W can be predicted by

$$(13) \qquad \hat{P}_W = \hat{P}_W^D + \hat{P}_W^R = \frac{\exp\left(X \cdot \hat{\alpha}_O + H \cdot \hat{\beta}_O + \log\left(\frac{1}{2}\left(\exp\left(I_D \cdot \hat{\gamma}\right) + \exp\left(I_R \cdot \hat{\gamma}\right)\right)\right)\right)}{\hat{D}_1 + \hat{D}_2},$$

where $\hat{D}_1$ and $\hat{D}_2$ are equal to D_1 and D_2, but with the estimated parameter vectors $\hat{\alpha}_O$, $\hat{\beta}_O$ and $\hat{\gamma}$ having been substituted in for $\alpha_O, \beta_O,$ and γ. Our assumptions about α^*_{DR} and β^*_{DR} imply that the state “others” is sufficiently different from the other states, including disability and rehabilitation, so that it is sensible to assume that the IIA property holds, but on the other hand similar enough to disability and rehabilitation that we can assume that the parameter vectors α and β are equal in all these three states. The similarity is in being out of the labor force, while the state “others” is different from disability or rehabilitation, because it avoids both the cost of applying for social security and the stigma of being dependent on the government. In addition, one cannot be assured of getting a full disability pension. Our finding above that long term sick leave has its largest effect on transitions out of full-time work to the state “others” is another reason for using the parameters of this state.

It follows from our assumptions that if the income received in the three states is the same, $I_D=I_R=I_O$, then the non-random part of utility received in the three states will also be equal, $u_D=u_R=u_O$. If there are mainly disadvantages of being disabled or in rehabilitation compared to being in the state “others” (such as having to participate in rehabilitation programs), this implication is unrealistic. In isolation, it implies that our assumptions place too great a value on being either disabled or in rehabilitation.

Table 4. Percent of transitions to disability or rehabilitation that are involuntary. Women aged 35-64 in full-time employment

	Year						
	1992	1993	1994	1995	1996	1997	1998
Simple method	64	61	61	63	65	67	67
Using identifying assumptions	67	65	66	68	69	71	71

Table 5. Percent of transitions to disability or rehabilitation that are involuntary. Women aged 35-64 in full-time employment. Annual average

	Age group					
	35-39	40-44	45-49	50-54	55-59	60-64
Simple method	57	65	65	67	68	64
Using identifying assumptions	58	68	70	73	74	66

Table 4 and Table 5 present two measures of the extent of involuntary transitions to social security, both based on the above estimation of the desire to voluntarily go onto social security. The first measure – the simple method in the tables - is calculated by the relative difference $\left(\left(\hat{P}-\hat{P}_W\right)/\hat{P}\right)$, while the measure based on identifying assumptions will be presented in the next section. Both measures indicate that about two thirds of those going to social security are doing so because of conditions at work. According to the simple residual measure, as shown in Table 4, the percent involuntary transitions $\left(\left(\hat{P}-\hat{P}_W\right)/\hat{P}\right)$ among all ages decreases from 64 percent in 1992 to 61 percent in 1993 and 1994, and then increases every year until reaching 67 percent in 1998. Considering the distribution over different ages we see in Table 5 that the percentage of involuntary transitions increases with age up to the age group 55-59 years, after which it then falls (many in the oldest age group have the possibility of early retirement).

Since our measures are based on the degree to which the predictions of P and P_W do not coincide, we are very reliant on the quality of our prediction of P_W. While our model may be simple, it should be noted that we are looking at reasonably homogeneous groups, married women in five year intervals, using a fairly large set of explanatory variables. The trend over time should be less dependent on how we project P_W than the levels. We see from Table 1 that there has been an increasing tendency for firms to push workers into disability or rehabilitation, with an exception for 1992. We suspect that our data for 1992 are influenced by the changes made in the social security system in 1991 and 1992.

These changes might have caused queues in the treatment of applications at the social security administration, and these queues might influence the inflow into disability benefit some time after the change in the system.

The effect of pension benefits can be illustrated by simulating the effects of a 10 percent increase in the level of such benefits. Such a change increases the number of individuals who voluntarily go to rehabilitation or disability by around 0.6 percentage points among the younger age groups, while having no effect on the transitions of the two oldest age groups.

Now define a government preference indicator, θ, measuring the degree to which government is more favorable to rehabilitation than the workers. It is defined as the difference between the acceptance ratio for rehabilitation and the acceptance ratio for disability,

$$(14) \qquad \theta = \frac{\hat{P}^R}{\hat{P}_W^R} - \frac{\hat{P}^D}{\hat{P}_W^D},$$

which is greater than zero if $\left(\hat{P}^R / \hat{P}^D\right) > \left(\hat{P}_W^R / \hat{P}_W^D\right)$. If the government preference indicator is greater than zero, $\theta>0$, the government has a relative stronger preference for rehabilitation than the workers, and if $\theta<0$ the government has a relative stronger preference for disability.

Table 6. The number of females to which government favors rehabilitation versus disability

	Age group					
	35-39	40-44	45-49	50-54	55-59	60-64
Favors disability, $\theta<0$	390	420	4,083	46,000	82,448	40,331
Favors rehabilitation, $\theta\geq 0$	216,868	261,408	272,748	169,914	21,569	226

Table 6 shows the distribution of θ across the different age groups. We see that for younger workers the government has a much stronger preference for rehabilitation than the workers, while for older workers the opposite is the case. This is probably due to the benefits of getting younger workers back into the labor force being large, because of the many years they can potentially stay in the labor force. On the other hand, for older workers the costs of rehabilitation may outweigh the expected benefits, since they are close to retirement.

5. Identifying the firm and the government probabilities

We now introduce an alternative method for calculating the probability that the firms wish to pension the workers if they do not want a pension themselves, P_F, and the probabilities that a desire for disability or rehabilitation will actually be accepted by the government, Q_W and Q_F. The method uses separate data on disability and rehabilitation to identify the combined aggregate probabilities P_F, Q_W and Q_F. Define P_G^D and P_G^R as the probabilities that the government will accept a wish to go to disability and rehabilitation, respectively. A detailed derivation of the results can be found in Appendix A. Assume that the basic equation given in Eq. (1) applies to disability and rehabilitation separately so that:

$$P^D = P_G^D \cdot P_W^D + \left(1 - P_W^D - P_W^R\right) \cdot P_G^D \cdot P_F^D \tag{15}$$

$$P^R = P_G^R \cdot P_W^R + \left(1 - P_W^D - P_W^R\right) \cdot P_G^R \cdot P_F^R . \tag{16}$$

Notice that we here, implicitly, assume that when screening individuals, the government does not distinguish between those applying voluntarily or involuntarily, so the same P_G^k applies to both P_W^k and P_F^k in Eqs. (15) and (16). In aggregate, the government acceptance probabilities will differ for voluntary and involuntary transitions, see appendix A1 and A2.

To identify the unknown probabilities P_F^D, P_G^D, P_F^R, and P_G^R we now introduce two identifying assumptions given by

$$\frac{\hat{P}^D / P_G^D}{\hat{P}^R / P_G^R} = \frac{\hat{P}_W^D}{\hat{P}_W^R} \cdot k \tag{17}$$

and

$$\frac{P_G^D \cdot P_F^D}{P_G^R \cdot P_F^R} = \frac{\hat{P}_W^D}{\hat{P}_W^R} , \tag{18}$$

where k is an adjustment factor taking into account whether the government has a stronger or weaker relative preference for rehabilitation compared to disability than the workers (as measured by the government preference indicator, θ, we introduced earlier). The probabilities P_W^D , P_W^R , P^D and P^R are assumed to be given by the predicted probabilities obtained earlier. The predicted probabilities $\hat{P}_F^D$, $\hat{P}_G^D$, $\hat{P}_F^R$ and $\hat{P}_G^R$ are treated as given, non-stochastic variables.

Ignoring prediction errors, the ratio on the left hand side of Eq. (17) is the ratio between the probability of an individual attempting to go into disability relative to rehabilitation (either because of own desire or because the firm desires it),

$$\frac{\hat{P}^D / P_G^D}{\hat{P}^R / P_G^R} = \frac{\hat{P}_W^D + \left(1 - \hat{P}_W^D - \hat{P}_W^R\right) \cdot P_F^D}{\hat{P}_W^R + \left(1 - \hat{P}_W^D - \hat{P}_W^R\right) \cdot P_F^R} .$$

The left hand side of Eq. (18) is the ratio between the probabilities of an individual actually being pushed by the firm into disability relative to being pushed into rehabilitation,

$$\frac{\left(1 - \hat{P}_W^D - \hat{P}_W^R\right) \cdot P_G^D \cdot P_F^D}{\left(1 - \hat{P}_W^D - \hat{P}_W^R\right) \cdot P_G^R \cdot P_F^R} = \frac{\text{number actually pushed by firms into disability}}{\text{number actually pushed by firms into rehabilitation}} .$$

According to our two identifying assumptions both these ratios are determined by the ratio of the number of workers wishing to go to disability relative to rehabilitation, $\hat{P}_W^D / \hat{P}_W^R$. We use the workers' preferences to determine these two ratios because it seems reasonable to think that the firms do not care whether the workers they want to get rid of go to disability or rehabilitation. In contrast, the individuals are assumed to both care about and having a possibility of influencing which state they go to.

To see how the adjustment factor *k* affects the probabilities we rewrite Eq. (17) as

(19) $$\frac{P_G^R}{P_G^D} = \left(\frac{\hat{P}^R}{\hat{P}_W^R} \middle/ \frac{\hat{P}^D}{\hat{P}_W^D} \right) \cdot k .$$

If $k>1$, we see that this will, cet. par., increase the probability of being accepted into rehabilitation, P_G^R, relative to being accepted into disability, P_G^D. We assume that *k* is determined by the government preference indicator θ, introduced earlier in Eq. (14).

When the probabilities of desiring to go to rehabilitation or disability are greater than the probability of actually doing so ($\hat{P}^R < \hat{P}_W^R$ and $\hat{P}^D < \hat{P}_W^D$), which we will refer to as the normal case, we assume that $k=1/(1-\theta)$. In this case, if the government has relatively stronger preferences for rehabilitation than the workers ($\hat{P}^R / \hat{P}^D > \hat{P}_W^R / \hat{P}_W^D$), then $\theta>0$ and $k>1$. Similarly, if the government has relatively stronger preferences for disability than the workers ($\hat{P}^R / \hat{P}^D < \hat{P}_W^R / \hat{P}_W^D$), then $\theta<0$ and $k<1$.

Table 7. Percent of age group in different categories and number of deleted observations

	Age group					
	35-39	40-44	45-49	50-54	55-59	60-64
i) $\widehat{P}^R < \widehat{P}_W^R$ and $\widehat{P}^D < \widehat{P}_W^D$	96.4	96.3	95.8	94.6	79.3	67.9
ii) $\widehat{P}^R \geq \widehat{P}_W^R$ and $\widehat{P}^D < \widehat{P}_W^D$	3.1	2.2	1.6	0.5	0.1	0.0
iii) $\widehat{P}^R < \widehat{P}_W^R$ and $\widehat{P}^D \geq \widehat{P}_W^D$	0.0	0.0	0.0	0.5	14.9	26.4
iv) $\widehat{P}^R \geq \widehat{P}_W^R$ and $\widehat{P}^D \geq \widehat{P}_W^D$	0.4	1.5	2.7	4.5	5.6	5.6
Number of observations deleted	25	1	0	1	0	14

The identifying equations are changed when the normal case does not apply. If $\hat{P}^R \geq \hat{P}_W^R$, so that more workers are going into rehabilitation than the number wishing to do so, then we assume that the probability of being admitted to rehabilitation is equal to one, $P_G^R = 1$ (with this requirement replacing the second assumption) and that *k=1/θ*. In this case *θ* will always be greater than zero and *k* will usually be greater than one, unless there is a very large difference between $\hat{P}^R / \hat{P}_W^R$ and $\hat{P}^D / \hat{P}_W^D$. Similarly, if $\hat{P}^D \geq \hat{P}_W^D$, so that more workers are going into disability than the number wishing to do so, then we replace the second assumption by the requirement that the probability of being admitted to disability is equal to one, $P_G^D = 1$ and that *k=-θ*. In this case *θ* will always be less than zero and *k* will usually be less than one, skewing the government probabilities in the direction of disability.

If both $P^R \geq P_W^R$ and $P^D \geq P_W^D$, then we replace both assumptions (17) and (18) by the equations $P_G^R = 1$ and $P_G^D = 1$. In this case we assume that the individuals are not hindered in seeking either disability or rehabilitation.

Table 7 shows how many individuals fall into the different categories and how many observations are deleted due to the calculated probabilities being outside the interval [0,1]. For all age groups the normal case, case *i*) in the table, is predominant. For the age groups 55-59 and 60-64 there is also a sizable number of women who have a higher probability of going to disability than of desiring to do so.

The two identifying relationships together with the disaggregate equations (15) and (16) are sufficient to identify the four disaggregate variables P_F^D, P_G^D, P_F^R, and P_G^R and subsequently the aggregate probabilities P_F, Q_w and Q_F. One can solve these equations by letting Eq. (17) determine the ratio of the government acceptance probabilities, $\hat{P}_G^D / \hat{P}_G^R$, while Eq. (18) then determines the relative ratio of firm probabilities, $\hat{P}_F^D / \hat{P}_F^R$. Calculations of the firm and government probabilities in all cases can be found in Appendix A. For the normal case they are given as

$$P_G^D = \frac{\hat{P}^D}{\hat{P}_W^D} \cdot \frac{1 - \dfrac{\hat{P}^R}{\hat{P}_W^R} + \dfrac{\hat{P}^D}{\hat{P}_W^D}}{1 + \dfrac{\hat{P}^D}{\hat{P}_W^D}}, \qquad P_G^R = \frac{\hat{P}^R}{\hat{P}_W^R} \cdot \frac{1}{1 + \dfrac{\hat{P}^D}{\hat{P}_W^D}},$$

(20)

$$P_F^D = \frac{\hat{P}^R}{\hat{P}_W^R} \cdot \frac{\hat{P}_W^D}{1 - \hat{P}_W^D - \hat{P}_W^R} \cdot \frac{1}{1 - \dfrac{\hat{P}^R}{\hat{P}_W^R} + \dfrac{\hat{P}^D}{\hat{P}_W^D}}, \qquad \text{and} \qquad P_F^R = \frac{\hat{P}^D}{\hat{P}_W^D} \cdot \frac{\hat{P}_W^R}{1 - \hat{P}_W^D - \hat{P}_W^R}.$$

From this we can now calculate the aggregate probability $P_F = P_F^D + P_F^R$, and the aggregate probabilities Q_W and Q_F. The number of individuals who go involuntarily to disability or rehabilitation, using this method, are presented in Table 4 and Table 5. Using the identifying assumptions instead of the much simpler method described in the introduction gives us a 2 to 6 percent higher rate of involuntary transitions. Both methods show a fairly large difference between the number of involuntary transitions among the youngest age group and the other age groups. It seems that among women aged 35 to 39 a much higher proportion of the transitions to rehabilitation and disability occurs voluntarily. To some extent this may be due to a self-selection process where women who do not enjoy their work drop out of full-time employment as they get older.

6. Estimation of firm and government probabilities

To obtain a fuller description of the factors behind the increases in disability and rehabilitation, we use the logit model to estimate the relations for the firm probability P_F and the average government probability $Q=(Q_W+Q_F)/2$ separately for each age group. Since the estimated probabilities $\hat{P}_F^D$, $\hat{P}_G^D$, $\hat{P}_F^R$ and $\hat{P}_G^R$ are treated as non-stochastic variables, our estimates are conditional on these predicted values. Since the firm probability P_F and the average government probability $Q=(Q_W+Q_F)/2$ in these cases are a probability instead of the usual 0/1 transition variable, we applied two different estimation strategies giving qualitatively the same results. The two approaches where a grouped variable approach (blogit in Stata) with wage income grouped in NOK 25,000 intervals and a GLM (Generalized Linear Model) approach in Stata, which allowed us to do the estimations directly on the calculated probabilities.

Our earlier estimation of the desire for disability or rehabilitation, P_W, did not use all the available variables, being confined to income, health, the spouse's situation, whether the worker has a low education and the number of children. This was done, both because we believe this subset is most easily interpretable as determining utility independently of the work situation, and because we wished to have a small number of individual-specific variables when predicting the probabilities of going to disability or rehabilitation. We follow up this line of reasoning in the estimation of the relations for P_F and Q, using only variables for each probability that we think can be clearly linked to either the conditions on the job (in the case of P_F) or to the government screening process Q.

In estimating the relation for the firm probability P_F, we assume that the combination of wage income, unemployment rate, length and field of education, production sector and localization describes the job situation of a worker, while the available health variables are considered indicators of how well the worker is coping with his job. Time is not used as an explanatory variable in the estimation of the relations for P_W and P_F, because we in the case of workers and firms wish to emphasize explanatory variables that can be interpreted "easily". On the other hand, we do not believe it is possible to derive such "structural" relationships for the government screening process, therefore allowing Q to depend on a vector of time dummies. We interact time and a good prognosis, to see if there has been a change over time in the effect of a good prognosis (since many with a good prognosis end up on social security, one might expect that doctors over time become more reserved in giving this prognosis). In addition we use a relative age variable giving the age within the 5-year cohort we are looking at. For example, a 37 year old women will belong to the cohort 35-39 with relative age equal to 2 (37-35=2).

Tables 8 gives the estimated coefficients for the firm probabilities, controlling for 10 types of education, 10 production sectors and the 20 counties in Norway. Table 9 gives the estimated coefficients for the government probabilities. As with the table showing the estimated coefficients for P_W, we only report results after non-significant variables have been dropped. Table 8 shows that individuals in high income jobs have a higher probability of being pushed out by the firms, as also was noted in Section 3. This can be due to the fact that monitoring and regulating the output of high income workers can be more difficult than for low income workers. If this is the case, firms have fewer instruments to deal with high income workers who are not performing satisfactorily and therefore feel forced to increase the use of disability pensions. It might also be due to it being more difficult to fire high income workers, since they usually have worked longer at a firm.

Table 8. Some of the estimated coefficients for the firms' probability of wanting to push workers onto social security.* GML-estimation (see text)

	Age group					
	35-39	40-45	45-49	50-54	55-59	60-64
Log of wage income	0.93	0.96	0.69	0.52	0.77	0.92
	(0.10)	*(0.09)*	*(0.08)*	*(0.0)9*	*(0.11)*	*(0.14)*
Unemployment	-0.06	-0.07	-0.08	-0.06		-0.06
	(0.02)	*(0.02)*	*(0.01)*	*(0.01)*		*(0.02)*
Education level	0.22		-0.14	-0.13	-0.14	-0.11
	(0.08)		*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*
Education level squared	-0.02	-0.01				
	(0.00)	*(0.00)*				
Healthy	-	-	-	-	-	-
Not sick, but been on sick leave	2.76	2.45	2.31	2.43	2.54	2.09
	(0.12)	*(0.13)*	*(0.12)*	*(0.13)*	*(0.14)*	*(0.21)*
Sick < 60 days with good prog.	3.36	3.64	3.54	3.71	3.61	3.36
	(0.08)	*(0.07)*	*(0.07)*	*(0.07)*	*(0.08)*	*(0.11)*
Sick ≥ 60 days with good prog.	4.42	4.62	4.61	4.59	4.85	4.64
	(0.05)	*(0.05)*	*(0.04)*	*(0.04)*	*(0.05)*	*(0.07)*
Sick with a bad prognosis	5.38	5.19	5.20	5.37	5.47	5.56
	(0.07)	*(0.06)*	*(0.05)*	*(0.059*	*(0.06)*	*(0.07)*
Sick with no prognosis	3.13	3.28	3.09	3.11	3.20	3.05
	(0.09)	*(0.08)*	*(0.08)*	*(0.08)*	*(0.10)*	*(0.11)*
Number of observations	225,233	271,876	289,093	228,252	131,120	59,679
Log-likelihood	8218	9986	11901	10660	7121	4747
Number of parameters	24	23	23	24	16	15
Pseudo R^2	0.352	0.362	0.369	0.404	0.455	0.494

*:All the estimated coefficients can be found in Appendix D.
Standard errors in parentheses. Standard errors do not reflect that the left-hand-side variable is stochastic.
Non-significant variables have been dropped. A blank implies the variable was insignificant. - : implies a variable was dropped for other reasons.

Table 9. Estimated coefficients for government probabilities by age group

	Age group					
	35-39	40-44	45-49	50-54	55-59	60-64
Age within group	0.16	0.05	0.10	0.04	0.13	0.27
	(0.03)	*(0.00)*	*(0.00)*	*(0.02)*	*(0.00)*	*(0.03)*
Age within group squared	-0.02			0.01		0.02
	(0.01)			*(0.00)*		*(0.01)*
Health condition						
Healthy (reference)	-	-	-	-	-	-
Not sick but been on sick leave	3.42	3.69	4.19	6.31	-	2.93
	(0.07)	*(0.08)*	*(0.11)*	*(0.38)*		*(0.19)*
Sick <60 days with good prognosis	3.92	3.71	3.56	6.05	-	7.15
	(0.06)	*(0.09)*	*(0.09)*	*(0.26)*		*(1.15)*
Sick ≥60 days with good prognosis	4.20	5.07	6.02	8.77	-	6.32
	(0.06)	*(0.10)*	*(0.17)*	*(0.70)*		*(0.45)*
Sick with a bad prognosis	6.37	6.95	9.27	8.19	-	3.63
	(0.17)	*(0.27)*	*(0.97)*	*(0.66)*		*(0.11)*
Sick with no prognosis	3.72	3.98	4.45	5.06	-	5.40
	(0.06)	*(0.07)*	*(0.10)*	*(0.17)*		*(0.42)*
1992 (reference year)	-	-	-	-	-	-
1993	0.12	-0.11	-0.06		0.09	0.25
	(0.04)	*(0.03)*	*(0.02)*		*(0.02)*	*(0.04)*
1994	0.17	0.19	0.30	0.15		-0.10
	(0.04)	*(0.03)*	*(0.02)*	*(0.02)*		*(0.04)*
1995	0.64	0.34	0.40	0.31	0.22	0.43
	(0.04)	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.04)*
1996	0.50	0.36	0.37	0.34	0.40	0.45
	(0.04)	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.04)*
1997	0.34	0.38	0.40	0.30	0.27	0.49
	(0.04)	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.04)*
1998	0.61	0.33	0.53	0.45	0.44	0.82
	(0.04)	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.04)*
Constant	-3.50	-2.54	-2.24	-1.72	-1.23	-1.93
	(0.05)	*(0.02)*	*(0.02)*	*(0.03)*	*(0.02)*	*(0.05)*
Second order effects						
Sick with good prognosis x 1993			0.73		-	-
			(0.24)			
Sick with good prognosis x 1994		0.51			-	
		(0.18)				
Sick with good prognosis x 1995	-0.43	0.49			-	
	(0.11)	*(0.18)*				
Sick with good prognosis x 1996	-0.25	-0.29			-	
	(0.10)	*(0.14)*				
Sick with good prognosis x 1997			0.71		-	
			(0.21)			
Sick with good prognosis x 1998	-0.34	0.49	0.49		-	
	(0.10)	*(0.16)*	*(0.20)*			
Number of observations	225,233	271,876	289,093	228,252	123,978	59,459
Number parameters	17	17	16	13	7	14
Log-likelihood	38,272	65,677	87,361	79,390	53,943	23,992
Pseudo R^2	0.203	0.156	0.129	0.119	0.010	0.146

Standard errors in parentheses.

Non-significant variables have been dropped. A blank implies the variable was insignificant. - : implies a variable was dropped for other reasons.

The estimates also indicate that increasing unemployment will decrease the probability of being pushed out into rehabilitation or disability (unemployment generally fell in the period we are looking at). We thereby find support for the hypothesis that in periods of low unemployment more marginal workers are employed, leading to higher transition rates to disability. Sick leave has, as expected, a very strong effect on the firms' desire to get rid of a worker. Of notable results for the variables not reported in Table 8 (type of education, production sector and county), we find that in the transport sector firms are more likely to push individuals into disability (with non-significant results for age groups 40-44 and 55-59) than in other sectors, while firms in the financial sector are less likely to do so. Firms in the western part of Norway (Rogaland, Hordaland, and Sogn and Fjordane) have a lower probability of pushing women aged between 40 and 54 into disability, while in the northern part of Norway (Nordland, Troms and Finnmark) firms have an increased probability of doing so to older workers aged 50-64 compared with firms in the capital city, Oslo.

Table 10. Average predicted probabilities for going on social security 1992-1998. Percent

	Age group					
	35-39	40-44	45-49	50-54	55-59	60-64
$\bar{\hat{P}}$	1.3	1.4	1.6	2.2	3.1	6.0
$\bar{\hat{P}}_W$	4.7	2.4	1.9	1.9	1.8	4.2
$\bar{\hat{P}}_F$	1.3	1.4	1.6	2.1	2.9	5.3
$\bar{\hat{Q}}$	8.1	13.3	19.3	25.8	38.1	37.7

Table 9 shows that for all age groups the estimated time effects suggest there has been an increase in the probability that the government screening process will lead to a person getting rehabilitation or disability. The increase in the estimated time effects is not uniform, for example for some age groups there are a fall in 1997. The estimates indicate that the attempt made in 1991 to restrict the numbers of applicants being accepted in rehabilitation or disability had a temporary effect during the first couple of years, but then the acceptance rates started to increase. The emphasis on rehabilitation that has been at the center of reform efforts during the last 15 years may, unintentionally, have increased the total number going into either disability or rehabilitation. Increased possibilities for rehabilitation may have given workers better possibilities to exit the labor force, instead of only helping those otherwise destined for disability to return to the labor force.A summary of the average predicted probabilities across years for going onto social security (either disability or rehabilitation) is given in Table 10. From the table we see that the average probability of actually going onto social security, $\bar{\hat{P}}$, increases with age, while the average probability of desiring to go on social security, $\bar{\hat{P}}_W$, decreases with age (except for the oldest age group). The desire of the firms to push workers onto social security, $\bar{\hat{P}}_F$, and the probability of the government accepting an application for social security, $\bar{\hat{Q}}$, increases with age.

7. Decomposition of transitions into rehabilitation and disability benefit

We now decompose the change in rehabilitation and disability from 1992 to 1998 into seven factors, changing one factor at a time, and then predicting the resulting probabilities using the estimated relationships. Table 11 presents the decomposition for the six age groups we have studied, giving the percent of the total observed change due to each factor (each row includes all factors, thereby summing to 100 percent). Note that the contribution from a particular variable depends on the ordering of the changes; the numbering of the simulations are starting from the left of the table. Thus, the first column shows the increase in disability and rehabilitation (in percent of the total change) that occurs in two simulations where all variables are kept at their 1992 level except the size of the population (married women working full-time), which is set equal to that in 1992 and 1998, respectively. Based on the probabilities we get when the population is set equal to the one in 1998, the second column shows the change (increase) that occurs if we set the number of individuals who are on sick leave equal to the level found in 1998. The third column shows the effect of letting the composition of the cohort with respect to all demographic and firm characteristics (for example changes in education or in the sectors they are employed) reflect the situation in 1998 instead of in 1992 when the reference probabilities include both the effect of the 1998-population and the sick leave level of 1998. The fourth column measures the effect of change in the income variables[2] and the fifth column the effect of change in unemployment from 1992 to 1998. In the sixth column the effect of the dummies for year used in the prediction of the government acceptance probability are considered. Finally, the seventh column shows approximation and prediction errors.

The first column in Table 11 shows that the contribution from changes in the size of the population varies significantly across age groups during the period. The strongest contribution was among the married females aged 50-59, where the increase in group size accounted for half the change in transitions to social security. As expected, an increased number of workers on sick leave is the most important factor behind the increase in disability and rehabilitation, especially in the younger age

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[2] This simulation reflects the effects of changes in the income received when disabled or in rehabilitation compared to the income when working.

groups. Sick leave, disability and rehabilitation are closely related events. However, it is notable that factors other than sick leave have such an important impact. Changes in the population composition of the groups we are looking at have in isolation reduced the number of workers going to social security, while changes in the income received when disabled or in rehabilitation (compared to the income when working) have contributed to an increase in these transitions. Decreases in unemployment explain between 10 and 19 percent of the increase in disability and rehabilitation for all age groups except for women aged 50-59, for which the parameter estimate for unemployment was found to be insignificant. This indicates that more workers with marginal health are being employed into full-time positions.

Table 11. Decomposition of the transition from full-time employment into rehabilitation and disability from 1992 to 1998. Percent contribution by each factor

	Factors							
	1	2	3	4	5	6	7	
Age group[a]	Population	Number of workers on sick leave	Population composition	Income	Unemploy-ment	Year	Approx. & pred. errors	Sum
35-39	8	51	-8	5	12	28	3	100
40-44	16	62	-12	7	18	16	-7	100
45-49	16	56	-10	5	19	19	-6	100
50-54	47	32	-5	3	11	9	3	100
55-59	52	38	-4	4	0	10	1	100
60-64	0	64	-9	4	10	31	1	100
Total	29	47	-7	4	11	16	-1	100

a: Age in 1992

The year dummies enter only the government acceptance probabilities and indicate unexplained changes in the way the social security system works. They are the third largest factor after changes in population and in sick leave, being especially important for the youngest and oldest age groups.

8. Conclusions

Based on predictions of workers' desire for disability and rehabilitation we develop two measures for the extent to which transitions to social security are voluntary and the extent to which workers are pushed into disability or rehabilitation. Our tentative findings are that most women who go to disability or rehabilitation would have preferred to be able to continue working, if work conditions had been better matched with their capabilities. In addition, the percentage of involuntary transitions has been increasing over time. We find that the probability that a married women working full-time will wish to go on social security decreases with age (maybe due to a self-selection effect), while the probability that the firms wish to push such a worker onto disability increases with age. The probability of the government accepting a worker onto disability or rehabilitation also increases with age.

While changes in the probabilities affecting each worker are important, we find that the most important factors behind the observed increase in disability and rehabilitation are increases in the number of workers and the number on sick leave in each age group. Decreasing unemployment has increased the number of women going to disability or rehabilitation, indicating that increased employment draws less healthy workers into the labor force. Increases in benefits relative to labor income have increased the desire for leaving the labor force.

Our results are based on two sets of assumptions. First, that our estimation of the desire to leave the labor force can be used to predict the desire for going either to disability or rehabilitation, and second, that our identifying assumptions are reasonable. There is a need to investigate these assumptions more closely. Still, we think that our results indicate that, when discussing disability, it is important to focus as much on the behavior of the firm and on work conditions as on the behavior of the workers.

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Appendix A. Calculating the probabilities $P_{Fi}^D, P_{Gi}^D, P_{Fi}^R$, and P_{Gi}^R

For the normal case, with $\hat{P}_i^R < \hat{P}_{Wi}^R$ and $\hat{P}_i^D < \hat{P}_{Wi}^D$, we have the 4 equations, (A.1), (A.2), (A.3) and (A.4) in the 4 probabilities $P_{Fi}^D, P_{Gi}^D, P_{Fi}^R$ and P_{Gi}^R:

(A.1) $$\hat{P}_i^D = P_{Gi}^D \cdot \hat{P}_{Wi}^D + \left(1 - \hat{P}_{Wi}^D - \hat{P}_{Wi}^R\right) \cdot P_{Gi}^D \cdot P_{Fi}^D ,$$

(A.2) $$\hat{P}_i^R = P_{Gi}^R \cdot \hat{P}_{Wi}^R + \left(1 - \hat{P}_{Wi}^D - \hat{P}_{Wi}^R\right) \cdot P_{Gi}^R \cdot P_{Fi}^R ,$$

(A.3) $$\frac{P_{Gi}^R}{P_{Gi}^D} = \frac{\hat{P}_i^R}{\hat{P}_i^D} \cdot \frac{\hat{P}_{Wi}^D}{\hat{P}_{Wi}^R} \cdot k_i ,$$

(A.4) $$\frac{P_{Fi}^D}{P_{Fi}^R} = \frac{P_{Gi}^R}{P_{Gi}^D} \cdot \frac{\hat{P}_{Wi}^D}{\hat{P}_{Wi}^R} ,$$

where i denotes individual, $k_i = \dfrac{1}{1-\theta_i}$, and $\theta_i = \dfrac{\hat{P}_i^R}{\hat{P}_{Wi}^R} - \dfrac{\hat{P}_i^D}{\hat{P}_{Wi}^D}$.

The parameter θ_i is in the normal case always less than 1, so $k_i = 1/(1-\theta_i)$ will always increase the probability of P_{Gi}^R relative to the probability of P_{Gi}^D.

Eqs. (A.1) and (A.2) can be rewritten as

$$\hat{P}_i^D - P_{Gi}^D \cdot \hat{P}_{Wi}^D = \left(1 - \hat{P}_{Wi}^D - \hat{P}_{Wi}^R\right) \cdot P_{Gi}^D \cdot P_{Fi}^D ,$$

$$\hat{P}_i^R - P_{Gi}^R \cdot \hat{P}_{Wi}^R = \left(1 - \hat{P}_{Wi}^D - \hat{P}_{Wi}^R\right) \cdot P_{Gi}^R \cdot P_{Fi}^R .$$

Dividing the first of these equations with the second one and using Eq. (A.4) one gets

(A.5) $$\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D} - \frac{\hat{P}_i^R}{\hat{P}_{Wi}^R} = P_{Gi}^D - P_{Gi}^R ,$$

or equivalently

$$\theta_i = \frac{\hat{P}_i^R}{\hat{P}_{Wi}^R} - \frac{\hat{P}_i^D}{\hat{P}_{Wi}^D} = P_{Gi}^R - P_{Gi}^D .$$

In the normal case, the parameter θ_i indicates the difference in the rehabilitation and disability ratios, which is the same as the difference in the government admittance probabilities. If $\theta_i > 0$, then $P_{Gi}^R > P_{Gi}^D$, and if $\theta_i < 0$, then $P_{Gi}^R < P_{Gi}^D$.

A.1 Calculating the government probabilities P_{Gi}^R and P_{Gi}^D in the normal case

Eq. (A.3) can be written

$$P_{Gi}^{R} = \frac{\hat{P}_i^R}{\hat{P}_{Wi}^R} \cdot k_i \cdot \frac{\hat{P}_{Wi}^D}{\hat{P}_i^D} \cdot P_{Gi}^D .$$

Inserting for P_{Gi}^R in Eq. (A.5), gives us

(A.6) $$P_{Gi}^{D} = \frac{\dfrac{\hat{P}_i^D}{\hat{P}_{Wi}^D} - \dfrac{\hat{P}_i^R}{\hat{P}_{Wi}^R}}{\dfrac{\hat{P}_i^D}{\hat{P}_{Wi}^D} - \dfrac{\hat{P}_i^R}{\hat{P}_{Wi}^R} \cdot k_i} \cdot \frac{\hat{P}_i^D}{\hat{P}_{Wi}^D} .$$

In the same manner we find P_{Gi}^R by inserting

$$P_{Gi}^{D} = \frac{\hat{P}_i^D}{\hat{P}_{Wi}^D} \cdot \frac{1}{k_i} \cdot \frac{\hat{P}_{Wi}^R}{\hat{P}_i^R} \cdot P_{Gi}^R$$

into Eq. (A1) leading to

(A.7) $$P_{Gi}^{R} = \frac{\dfrac{\hat{P}_i^D}{\hat{P}_{Wi}^D} - \dfrac{\hat{P}_i^R}{\hat{P}_{Wi}^R}}{\dfrac{\hat{P}_i^D}{\hat{P}_{Wi}^D} - \dfrac{\hat{P}_i^R}{\hat{P}_{Wi}^R} \cdot k_i} \cdot \frac{\hat{P}_i^R}{\hat{P}_{Wi}^R} \cdot k_i .$$

The government probabilities are always positive in the normal case with $\hat{P}_i^R \big/ \hat{P}_{Wi}^R < 1$ and $\hat{P}_i^D \big/ \hat{P}_{Wi}^D < 1$. This can be seen by inserting for

$$k_i = \frac{1}{1-\theta_i} = \frac{1}{1 - \dfrac{\hat{P}_i^R}{\hat{P}_{Wi}^R} + \dfrac{\hat{P}_i^D}{\hat{P}_{Wi}^D}} > 0$$

into Eqs. (A.6) and (A.7), giving us

$$P_{Gi}^{D} = \frac{1 - \dfrac{\hat{P}_i^R}{\hat{P}_{Wi}^R} + \dfrac{\hat{P}_i^D}{\hat{P}_{Wi}^D}}{1 + \dfrac{\hat{P}_i^D}{\hat{P}_{Wi}^D}} \cdot \frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}$$

$$P_{Gi}^{R} = \frac{1 - \dfrac{\hat{P}_i^R}{\hat{P}_{Wi}^R} + \dfrac{\hat{P}_i^D}{\hat{P}_{Wi}^D}}{1 + \dfrac{\hat{P}_i^D}{\hat{P}_{Wi}^D}} \cdot \frac{\hat{P}_i^R}{\hat{P}_{Wi}^R} \cdot \frac{1}{1 - \dfrac{\hat{P}_i^R}{\hat{P}_{Wi}^R} + \dfrac{\hat{P}_i^D}{\hat{P}_{Wi}^D}} = \frac{1}{1 + \dfrac{\hat{P}_i^D}{\hat{P}_{Wi}^D}} \cdot \frac{\hat{P}_i^R}{\hat{P}_{Wi}^R} .$$

These two equations can equivalently be written

$$P_{Gi}^{D}=\frac{(1-\theta_i)\cdot\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}}{1+\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}}$$

$$P_{Gi}^{R}=\frac{\frac{\hat{P}_i^R}{\hat{P}_{Wi}^R}}{1+\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}}=\frac{\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}+\frac{\hat{P}_i^R}{\hat{P}_{Wi}^R}-\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}}{1+\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}}=\frac{\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}+\theta_i}{1+\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}},$$

with

$$\frac{P_{Gi}^R}{P_{Gi}^D}=\frac{\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}+\theta_i}{(1-\theta_i)\cdot\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}}=\frac{1+\theta_i\cdot\frac{\hat{P}_{Wi}^D}{\hat{P}_i^D}}{1-\theta_i}=\frac{1-\theta_i+\theta_i\cdot\left(1+\frac{\hat{P}_{Wi}^D}{\hat{P}_i^D}\right)}{1-\theta_i}=1+\theta_i\cdot\frac{1+\frac{\hat{P}_{Wi}^D}{\hat{P}_i^D}}{1-\theta_i},$$

so that if $\theta_i>0$ then $P_{Gi}^R>P_{Gi}^D$, and if $\theta_i<0$ then $P_{Gi}^R<P_{Gi}^D$.

The number of individuals who voluntarily go to disability or rehabilitation is given by

$$\left(P_{Gi}^D\cdot\hat{P}_{Wi}^D+P_{Gi}^R\cdot\hat{P}_{Wi}^R\right)\cdot n_i=\left(\frac{(1-\theta_i)\cdot\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}}{1+\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}}\cdot\hat{P}_{Wi}^D+\frac{1}{1+\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}}\cdot\frac{\hat{P}_i^R}{\hat{P}_{Wi}^R}\cdot\hat{P}_{Wi}^R\right)\cdot n_i$$

$$=\frac{\hat{P}_i^D+\hat{P}_i^R-\theta_i\cdot\hat{P}_i^D}{1+\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}}\cdot n_i,$$

where η_i is an error term. Thus, the total probability that the government accepts a worker who desires disability becomes

(A.8) $$Q_{Wi}=\frac{P_{Gi}^D\cdot\hat{P}_{Wi}^D+P_{Gi}^R\cdot\hat{P}_{Wi}^R}{\hat{P}_{Wi}^D+\hat{P}_{Wi}^R}=\frac{(1-\theta_i)\cdot\hat{P}_i^D+\hat{P}_i^R}{\left(1+\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}\right)\left(\hat{P}_{Wi}^D+\hat{P}_{Wi}^R\right)}.$$

A.2 Calculating the firm probabilities P_{Fi}^R and P_{Fi}^D in the normal case

We can now find P_{Fi}^D and P_{Fi}^R by inserting the expressions for P_{Gi}^D and P_{Gi}^R into the disaggregated probability equations (A1) and (A2), which can be rewritten as

(A.9) $$P_{Fi}^D=\frac{1}{P_{Gi}^D}\cdot\frac{\hat{P}_i^D}{1-\hat{P}_{Wi}^D-\hat{P}_{Wi}^R}-\frac{\hat{P}_{Wi}^D}{1-\hat{P}_{Wi}^D-\hat{P}_{Wi}^R},$$

(A.10) $$P_{Fi}^R = \frac{1}{P_{Gi}^R} \cdot \frac{\hat{P}_i^R}{1-\hat{P}_{Wi}^D - \hat{P}_{Wi}^R} - \frac{\hat{P}_{Wi}^R}{1-\hat{P}_{Wi}^D - \hat{P}_{Wi}^R} .$$

Now inserting the expression we found for P_{Gi}^D in Eq. (A.6) into Eq. (A.9) and rearranging, we get

$$P_{Fi}^D = \frac{1-k_i}{\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D} - \frac{\hat{P}_i^R}{\hat{P}_{Wi}^R}} \cdot \frac{\hat{P}_i^R}{\hat{P}_{Wi}^R} \cdot \frac{\hat{P}_{Wi}^D}{1-\hat{P}_{Wi}^D - \hat{P}_{Wi}^R} .$$

In the same manner we find P_{Fi}^R by inserting Eq. (A.7) into Eq. (A.10) to get

$$P_{Fi}^R = \frac{1-k_i}{\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D} - \frac{\hat{P}_i^R}{\hat{P}_{Wi}^R}} \cdot \frac{\hat{P}_i^D}{\hat{P}_{Wi}^D} \cdot \frac{\hat{P}_{Wi}^R}{1-\hat{P}_{Wi}^D - \hat{P}_{Wi}^R} \cdot \frac{1}{k_i} .$$

Inserting for

$$k_i = \frac{1}{1-\theta_i} = \frac{1}{1 - \frac{\hat{P}_i^R}{\hat{P}_{Wi}^R} + \frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}} > 0$$

and

$$1-k_i = \frac{-\theta_i}{1-\theta_i} = \frac{\frac{\hat{P}_i^D}{\hat{P}_{Wi}^D} - \frac{\hat{P}_i^R}{\hat{P}_{Wi}^R}}{1 - \frac{\hat{P}_i^R}{\hat{P}_{Wi}^R} + \frac{\hat{P}_i^D}{\hat{P}_{Wi}^D}}$$

we get

(A.11) $$P_{Fi}^D = \frac{\hat{P}_i^R}{\hat{P}_{Wi}^R} \cdot \frac{\hat{P}_{Wi}^D}{1-\hat{P}_{Wi}^D - \hat{P}_{Wi}^R} \cdot \frac{1}{1-\theta_i}$$

and

(A.12) $$P_{Fi}^R = \frac{\hat{P}_i^D}{\hat{P}_{Wi}^D} \cdot \frac{\hat{P}_{Wi}^R}{1-\hat{P}_{Wi}^D - \hat{P}_{Wi}^R} .$$

It is easily seen that both P_{Fi}^D and P_{Fi}^R will always be positive as long as $\hat{P}_i^R / \hat{P}_{Wi}^R < 1$, $\hat{P}_i^D / \hat{P}_{Wi}^D < 1$ and $\hat{P}_{Wi}^D + \hat{P}_{Wi}^R < 1$ (which by construction is always the case).

The sum of the firm probabilities, P_{Fi}^R, is given by

(A.13) $$P_{Fi} = P_{Fi}^D + P_{Fi}^R = \left(\hat{P}_i^R \cdot \frac{\hat{P}_{Wi}^D}{\hat{P}_{Wi}^R} \cdot \frac{1}{1-\theta_i} + \hat{P}_i^D \cdot \frac{\hat{P}_{Wi}^R}{\hat{P}_{Wi}^D} \right) \cdot \frac{1}{1-\hat{P}_{Wi}^D - \hat{P}_{Wi}^R} ,$$

while the aggregate probability that individual *i* will be pushed out by the conditions at work is given by

$$\left(1-\hat{P}_{Wi}^{D}-\hat{P}_{Wi}^{R}\right)\left(P_{Gi}^{D}P_{Fi}^{D}+P_{Gi}^{R}P_{Fi}^{R}\right)=\frac{\hat{P}_{i}^{D}\cdot\frac{\hat{P}_{i}^{R}}{\hat{P}_{Wi}^{R}}+\hat{P}_{i}^{R}\cdot\frac{\hat{P}_{i}^{D}}{\hat{P}_{Wi}^{D}}}{1+\frac{\hat{P}_{i}^{D}}{\hat{P}_{Wi}^{D}}}.$$

Taken together, the total probability that the government accepts a worker who does not desire disability becomes

(A.14) $$Q_{Fi}=\frac{P_{Gi}^{D}\cdot P_{Fi}^{D}+P_{Gi}^{R}\cdot P_{Fi}^{R}}{P_{Fi}^{D}+P_{Fi}^{R}}=\frac{1}{1+\frac{\hat{P}_{i}^{D}}{\hat{P}_{Wi}^{D}}}\cdot\frac{\frac{\hat{P}_{i}^{D}}{\hat{P}_{Wi}^{D}}\cdot\hat{P}_{i}^{R}+\frac{\hat{P}_{i}^{R}}{\hat{P}_{Wi}^{R}}\cdot\hat{P}_{i}^{D}}{\frac{\hat{P}_{i}^{D}}{\hat{P}_{Wi}^{D}}\cdot\hat{P}_{Wi}^{R}+\frac{\hat{P}_{i}^{R}}{\hat{P}_{Wi}^{R}}\cdot\hat{P}_{Wi}^{D}\cdot\frac{1}{1-\theta_{i}}}.$$

A.3 The non-normal case when $\hat{P}_{i}^{R}>\hat{P}_{Wi}^{R}$

In this case we assume that $P_{Gi}^{R}=1$ and $k_{i}=1/\theta_{i}$, and our 4 equations are then given by Eqs. (A.1) and (A.2) in addition to

(A.15) $$\frac{P_{Gi}^{R}}{P_{Gi}^{D}}=\frac{\hat{P}_{i}^{R}}{\hat{P}_{i}^{D}}\cdot\frac{\hat{P}_{Wi}^{D}}{\hat{P}_{Wi}^{R}}\cdot\frac{1}{\theta_{i}}$$

(A.16) $$P_{Gi}^{R}=1,$$

where θ_i can be greater than 1. We directly find from Eqs. (A.2) and (A.16) that

(A.17) $$P_{Fi}^{R}=\frac{\hat{P}_{i}^{R}-\hat{P}_{Wi}^{R}}{1-\hat{P}_{Wi}^{D}-\hat{P}_{Wi}^{R}}$$

and from Eq. (A.15)

(A.18) $$P_{Gi}^{D}=\frac{\hat{P}_{i}^{D}}{\hat{P}_{Wi}^{D}}\cdot\frac{\hat{P}_{i}^{R}\cdot\hat{P}_{Wi}^{D}-\hat{P}_{i}^{D}\cdot\hat{P}_{Wi}^{R}}{\hat{P}_{i}^{R}\cdot\hat{P}_{Wi}^{D}}.$$

From this we then find

(A.19) $$P_{Fi}^{D}=\frac{\hat{P}_{i}^{D}\cdot\hat{P}_{Wi}^{R}}{\hat{P}_{i}^{R}\cdot\hat{P}_{Wi}^{D}-\hat{P}_{i}^{D}\cdot\hat{P}_{Wi}^{R}}\cdot\frac{\hat{P}_{Wi}^{D}}{1-\hat{P}_{Wi}^{D}-\hat{P}_{Wi}^{R}}.$$

A.4 The non-normal case when $\hat{P}_i^D > \hat{P}_{Wi}^D$

In this case we assume that $P_{Gi}^D = 1$ and $k_i = -\theta_i$, and our 4 equations are then given by Eqs. (A.1) and (A.2) in addition to

(A.20) $$\frac{P_{Gi}^R}{P_{Gi}^D} = \frac{\hat{P}_i^R}{\hat{P}_i^D} \cdot \frac{\hat{P}_{Wi}^D}{\hat{P}_{Wi}^R} \cdot (-\theta_i)$$

(A.21) $$P_{Gi}^D = 1 .$$

The correction factor -θ_i is positive and decreases the probability P_{Gi}^R (because 0<-θ_i <1). As above in section A.3, we easily find the probabilities

(A.22) $$P_{Fi}^D = \frac{\hat{P}_i^D - \hat{P}_{Wi}^D}{1 - \hat{P}_{Wi}^D - \hat{P}_{Wi}^R}$$

(A.23) $$P_{Gi}^R = \frac{\hat{P}_i^R}{\hat{P}_{Wi}^R} \cdot \frac{\hat{P}_i^D \cdot \hat{P}_{Wi}^R - \hat{P}_i^R \cdot \hat{P}_{Wi}^D}{\hat{P}_i^D \cdot \hat{P}_{Wi}^R}$$

and

(A.24) $$P_{Fi}^R = \frac{\hat{P}_i^R \cdot \hat{P}_{Wi}^R}{\hat{P}_i^D \cdot \hat{P}_{Wi}^R - \hat{P}_i^R \cdot \hat{P}_{Wi}^D} \cdot \frac{\hat{P}_{Wi}^D}{1 - \hat{P}_{Wi}^D - \hat{P}_{Wi}^R} .$$

A.5 The non-normal case when both $\hat{P}_i^R > \hat{P}_{Wi}^R$ ***and*** $\hat{P}_i^D > \hat{P}_{Wi}^D$

In this case we have that both $P_{Gi}^R = 1$ and $P_{Gi}^D = 1$, and our 4 equations are then given by Eqs. (A.1) and (A.2) in addition

(A.25) $$P_{Gi}^R = 1$$

(A.26) $$P_{Gi}^D = 1 ,$$

leading to the firm probabilities

(A.27) $$P_{Fi}^D = \frac{\hat{P}_i^D - \hat{P}_{Wi}^D}{1 - \hat{P}_{Wi}^D - \hat{P}_{Wi}^R}$$

and

(A.28) $$P_{Fi}^R = \frac{\hat{P}_i^R - \hat{P}_{Wi}^R}{1 - \hat{P}_{Wi}^D - \hat{P}_{Wi}^R} .$$