THE KOREAN ECONOMIC REVIEW
Volume 7, Number 1, Summer 1991.

DISABILITY, WORK ENVIRONMENT AND JOB DURATION: A HAZARD MODEL APPROACH

YANG WOO KIM*

I. INTRODUCTION

Full employment of the disabled is an important but elusive policy goal. While neraly 90 percent of able-bodied men were in the labor force in the U.S. in 1988, only about 35 percent of men with work disabilities were.[1] The increased incidence of poor health is an inevitable consequence of aging society. How health conditions impact on work, therefore, is important for social policy. In this paper we will follow workers who suffer a health condition which limits their ability to work at their job. At the onset, for instance, chronic disease may have only a small effect on one's ability and willingness to work, but, as this health condition worsens, the risk of dropping out of the labor force may rise. This may be caused by the increasing severity of the condition, but it may also depend on the willingness of an employer to adjust the workplace environment to compensate for a health based impairment or the labor force and applying for disability insurance benefits will be successful.

If a goal of society is to mitigate the effect of such chronic health condition as arthritis on work capacity and performance, it is necessary to understand not only how medical interventions may reduce the risk of job loss but also how social policy interventions mitigate or exacerbate this risk. Recently the U.S. House passed the Americans with Disabilities Act (ADA) of 1990.[2] This Act is one example of the social policy intervention which is meant to reduce discrimination against the handicapped. Under this Act, employers have the obligation to reasonably accommodate a disabled worker unless it would result in undue hardship on the operation of business. Supporters of the ADA believe this Act will increase employer's willingness to change the work environment to both accommodate new workers

*Institute for Monetary and Economic Studies, the Bank of Korea. This study was supported by a research award by the U.S. Arthritis Foundation. My thanks go to professors R.V. Burkhauser, J.S. Butler, G.A. Slotsve, K.H. Anderson and T.Pincus and anonymous referees for their critical comments.

[1]U.S. Bureau of the Census, 1989.

[2]See Burkhauser(1990) for details.

with disabilities and prolong the workife of employed workers who suffer health conditions that otherwise would lead them to leave their job.

This study traces out the pattern of the job departures of male workers who suffer health conditions which limit their ability to work. A worker might respond to a work limiting condition by reducting work effort or eventually leaving his job. How long a worker will stay on the job may vary according to individual attributes and characteristics of the work situation as well as the severity of health conditions.

The economic model which forms the basis of this study will trace the consequences of a health condition on work behavior. This study is unique in its ability to follow individual workers from the onset of a work limitation due to a health condition to job exit. Using life table analysis, the risk of job exit following onset is shown and then a hazard model is used to estimate the relative influence of health variables and socioeconomic variables on that risk. But we are especially interested in whether an employer who makes an adjustment in the workplace increase the likelihood that a worker with health problem will continue to stay on the job.

II. DATA

The most recent data set appropriate to test our model is the 1978 Survey of Disability and Work from the United States. This national survey was the most recent survey conducted by the Social Security Administration on the prevalence of work disability among working age populations in the United States. It consists of two frames: the HIS (Health Interview Survey) frame and the SSA (Social Security Administration) frame. The sample used in this paper is the HIS frame which consists of 5,652 persons which is representative of the 127 million general population of nonistitutionalized persons age 18-64 as of June 1978 in the continental United States.

Respondents were asked the following questions concerning their health: 'Which of the following conditions or illnesses do you have NOW that a DOCTOR has told you about?' A list of 37 health conditions was then read by an interviewer. If the respondent reported a health problem other than the 37 conditions, then a supplemental list of 15 health conditions was read. Respondents were then asked to indicate the year in which the condition first limited the ability to work. Additional retrospective information on labor market activity, including job change status, occupation and industry, employer's attitude, at the time of onset is available. In addition, the survey data was matched with the Social Security earnings history for each respondent. From the earnings history, the yearly earnings of the worker since 1951 and the number of quarters of converage at the social security covered employment since 1938 are available.

Combining these two data sets, we are able to trace employment histories of workers with chronic health conditions from the time health began to limit work

until they left their employer. In the empirical model, the behavior of prime age men, who were less than age 60 at the survey date and were older than age 20 at the onset of their condition, is analyzed.[3] Because we are interested in evaluating the response of employers, we limit our analysis to non-selfemployed men who were employed at the onset of their work limitation.[4] Those with missing information on either the time of work limitation or the main health condition are deleted. As a result of this selection process, we are able to trace the outcomes of 348 men.

Each respondent was asked the calendar year that his health condition first began to limit his work. So it is a straightforward exercise to measure the year of onset. Unfortunately this is not the case for measuring duration following onset. Each respondent was asked if he stayed with the firm after onset. If respondent changed jobs or stopped working immediately after onset then we know he exited in his first post-tenure year. If he stayed with the same employer after onset and was still employed on that job in 1978, then the time elapsed was from onset to 1978. For all other cases, social security earnings records are used to estimate job exit by looking for breaks in quarters of coverage not related to reaching the social security taxable maximum and by comparing drops in wage earnings relative to previous years.

III. EMPIRICAL MODEL

In order to take full advantage of the longitudinal aspect of the data, time series models are necessary. As to whether state or time is discrete or continuous respectively, there can be four different versions of a time series model.[5] A continuous-state, discrete-time model refers to the usual time series model in a narrow sense. On the other hand, Markov chain models may be characterized as discrete-state, discrete-time models. Hazard modelling has experienced rapid development in economics as well as in sociology and the biomedical area. A hazard model looks explicitly at the risk per unit of time over which individuals remain at risk. There are some advantages to using the hazard analysis. First, we can capture the distribution of timing of an event in addition to its occurrence itself over a specific interval. Second, it is easy to handle the right censoring problem in a hazard model. Ordinary regression specifications are not well adapted to offsetting censoring problems. Third, time varying explanatory variables can be incorporated into the

[3]We limit our sample to those under age 60 in 1978 to factor out job exit risks associated with reaching retirement age for social security of employer pensions. We also want to exclude those with little or no work history prior to onset so we excluded those below age 20 at onset.

[4]We also exclude government employees because they were not covered by social security until the 1980s.

[5]Amemiya(1985) chapter 11.

[**Table 1**] Sample Hazard of Leaving Onset Job: Life Table*

Years since onset	Exit from Job (A)	Censored (stayed at Job)	Survived (B)	Left A_t/B_{t-1}	Hazard rate	Survival
start			348			
1	118	9	221	33.9%	0.41	0.66
2	71	19	131	32.1%	0.40	0.44
3	22	7	102	16.8%	0.19	0.36
4	18	8	76	17.6%	0.20	0.29
5	7	12	57	9.2%	0.11	0.27
6	4	8	45	7.0%	0.08	0.25
7	6	7	32	13.4%	0.16	0.21
8	3	0	29	9.4%	0.10	0.19
9+	16	9	22	55.2%		
Total	269	79	348			
(%)	(77.3%)	(22.7%)	(100%)			

*Sample size falls below 25 after eight years.

analysis.

A discrite time approach[6] is appropriate when an event can occur at any time, but available data only records the event by intervals. With such data, a continuous time hazard technique using interval hazard estimation is also appropriate.[7] The model adopted in this study is a continuous time hazard approach.

Table 1 reports sample hazard rates of exit from onset job in each period calculated by the life table method. The table measures the probability of a worker's leaving his job during each year following the onset of a health induced work limitation given that he survived the previous period. These events are recorded in discrete time since we konw only the year in which the job exit occurred, and not the exact month and day. This implicit assumption is that censoring occurred randomly during the interval, hence the non-survivors were exposed on average for one-half the interval. Out of our sample of 348 male workers employed at the onset of a work limitation, 77 percent eventually left their onset job either to go to another job or by dropping out of the labor force. The pattern shows that most of the

[6]The discrete time hazard approach was suggested by Cox(1972) and used by others(Allison 1982, 1984). In this study, estimation, using a discrete time approach, can be accomplished by specifying a linear probability model of the risk of a first employer change and estimating it by the logit transformation:

$$\log \{P_t/(1-P_t)\} = {}_t + \beta X,$$

where P_t is the hazard rate of job exit at time t; ${}_t$ are a set of dummy variables for each year spent at the onset job, which capture any autonomous variations in the hazard over time, and X is vector of time constant variables that are assumed to influence the behavior of individuals.

[7]See Butler et al.(1989).

exits occurred within five years and 44 percent of the exits occurred within one year (118 out of 269).[8] The hazard rate is defined as the probability that an event will occur at a particular time to a particular individual, given that the individual is at risk at that time. In this study, the hazard rate is the probability of leaving the employer within a particualr year for those who have not yet left their onset job. The rate is quite high during the first two years then falls in the third year, but does not seem to show any clear pattern thereafter.

However, this simple life table result is based on the assumption of no heterogeneity across individuals. Our goal is to estimate a regression type model in which the probability of an exit from the job held at onset depends on explanatory variables. In the next section a formal empirical model based on the hazard technique and the specification of the hazard equation will be presented.[9]

IV. ECONOMETRIC TECHNIQUE-HAZARD MODEL

In this application, the hazard rate is the probability of leaving one's employer at the onset job. The decision for leaving is modelled as a single transitional process from working to leaving. A worker will exit the job if he perceives the gain from moving to be positive.

Suppose the cumulative probability that a person leaves his onset job by time t is given by

$$(1)\quad G(t) = 1\text{-}\exp\left[-\int_0^t h(u)du\right]$$

Associated with this distribution function is the density function

$$(2)\quad g(t) = \{1\text{-}G(t)\} \times h(t),$$

describing the likelihood of job exit at time t. The instantaneous hazard rate is the conditional probability of leaving the onset job at t, given that the person has not left before t. It is

[8]The distribution of job exit behavior obtained from a cross-tab analysis of survey data showed a strikingly different result from this imputed job tenure distribution. According to the cross-tab, 231 answered that they stayed with the same employer, 38 found a new employer and the rest, 80, stopped working or became unemployed. However Table 1 suggests that 152(=231-79) of the workers who reported that they stayed with the same employer left their onset job sooner or later. This implies that a cross-sectional regression such as a multinomial logit may give us a misleading result and that our dynamic method is more desirable.

[9]For the complete lifecycle labor supply model under uncertainty, see Kim(1990). Since the main goal of this paper is to test the effect of employer's accommodation on worket's decision, the derivation of the theoretical model is omitted.

(3) $h(t) = g(t)/\{1\text{-}G\ (t)\}$.

To make the distribution function G(t) a function of individual attributes, we specify the hazard rate in the form

(4) $h(t) = h_1(X) \times h_2(t) \times v$.

The first component accounts for observable variation across individuals and is modelled as an exponential function

(5) $h_1 = \exp\{X'b\}$

X is the vector of the determinats of work behavior such as personal characteristics. They may vary (e.g., age, health)[10] or remain fixed (e.g., sex, race) over the sample period.

The second component h_2 (t) shows the time profile to job exit after the onset of a work limitation once individual differences are held constant. I use the quardratic form to consider the nonmonotonicity of time dependence:

(6) $h_2(t) = \exp\{\alpha t + \beta t^2\}$

The third component captures unobserved individual heterogeneity. This heterogeneity may exist because of omitted variables, uncertainty or differences in the distribution function across individuals. For example a less motivated person will exit his job more quickly, leaving behind those less likely to move. If these differences are not controlled, there may be spurious duration dependence. To estimate the likelihood function, unobserved factors are integrated out by assuming either a gamma or lognormal distribution or by allowing them to take a general semi-parametric form.

Then it is straightforward to specify the likelihood function for a variety of samle observations. For those who leave the onset job, the year of job exit is known. The probability of this event occurring between t_j and $t_j + s_j$ is:

(7) $G_j\ (t_j + s_j) - G_j(t_j)$

Since information is available on the beginning date of the spell (i.e., time of

[10]To incorporate changing variables into the model requires interpolating the data to those intervals for which no information is available. Interpolating the data, however, involves significant cost since the time profile of the hazard may become meaningless. Thus Mitchell(1986) fixes all the regressors because information on men with arthritis is only available at two times. I will follow this strategy and let the time profile take care of the situation.

onset), our measure of duration does not suffer from left censoring. However some spells are censored on the right, i.e., some workers do not leave the labor force before the end of the survey. In this case, we merely know that the ultimate duration of the spell exceeds the observed final value, and hence the duration is the length of time until the end of the survey. For these individuals, the probability of not leaving the onset job is:

$$(8)\quad 1\text{-}G_i\ (t_i + u)$$

Combining the incomplete spell component together with complete spell component yields the following likelihood function for the N_1 disabled persons who have not left and N_2 persons who have left their onset job:

$$(9)\quad L = \prod_{i=1}^{N_1} 1\text{-}G_i\ (t_i + u) \prod_{j=1}^{N_2} G_j\ (t_j + s_j) - G_j(t_j).$$

V. SPECIFICATION OF THE HAZARD RATE EQUATION

Since the purpose of this study is to describe more precisely the timing of exit from the onset job after a work limiting health problem occurred, rather than to specify a full explanatory model, time varying variables are not explicityly included. Instead a time dependence variable captures those factors for which incidence and severity change over time. The fixed explanatorys for h_1 in equation (5) include socio-economic factors, health status variables, as well as a variable unique to this data set, i.e. whether the employer accommodate the worker after his health condition began to affect his work. See Table 2.

The replacement rate is the key variable in most economic based studies of the work effort of disabled men. It was created using information from individual social security earnings history records. An impaired worker who expects a lower wage in the presence of poor health has a lower opportunity cost of alternative used of time. If he can recoup most of the income loss by conforming to the eligibility rules for Social Security disability Insurance (DI), this will lead to reduced market work or withdrawal from the labor force. We used the same method developed by other researchers (for instance: Leonard 1979; Halpern and Hausman 1986; and Bound 1989) to calculate the potential replacement rates. Average Monthly Wages (AMW) was computed for the year of onset and then the benefit formula used in that year was applied to get the Primary Insuracne Amount (PIA). We then explicitly recognize that that there is some degree of uncertainty related to acceptance onto DI rolls by estimating a probit model of DI acceptance from a subsample of DI applicants.[11] A replacement rate was calculated as the ratio of

[11]For the detail of derivation. see Kim(1990).

[**Table 2**] Definitions of Variables and the Summary Statistics for the Sample

Variables	Definitions	Sample Mean (standard error)
Replacement rate	PIA/AMW.	0.57(0.27)
Age at onset	Age at onset, Years	39.8(10.0)
Married at onset	Binary variable = 1 if married	0.78(0.41)
Nonwhite	Binary variable = 1 if nonwhite	0.18(0.39)
Had savings	Binary variable = 1 if a worker had savings at onset	0.47(0.50)
Education	Years of formal education	10.3(3.55)
Help	Binary variable = 1 if at the onset of work limitation the employer provided aids to help respondent remain on the job. (Instrumental variable is used to solve endogeneity problem.)	0.30(0.46)
Job tenure at onset job	Years of job tenure at the onset job until work limitation occurred.	9.76(8.86)
Experience	Total sum of quarters of coverage earned at the covered employment for all his life until work limitation occurred.	66.9(36.8)
Occupation		
White collar	Binary variable = 1 if the occupation of the respondent at the onset job is classified as a professional or managerial postion.	0.17(0.37)
Physical demand	Estimated summary scores of selected occupation characteristics	3.73(2.45)
Strength	from DOT matched for the 591 occupational categories in 1970 Census.(See text)	2.93(0.68)
Health		
Comorbidity	Binary variable = 1 if a respondent had multiple health conditions at onset.	0.70(0.21)
Cardiovascular	Binary variable = 1 if main health condition is one of cardiovascular disease group.	0.22(0.41)
Musculoskeletal	Binary variable = 1 if main health condition is one of musculoskeletal disease group.	0.44(0.50)

PIA to AMW. This replacement rate was then multiplied by the probability of a successful DI claim variable. Another economic variable included is a binary variable concerning whether or not he had savings at onset.

Demographic characteristics which might affect the labor force participation behavior of a worker over a lifetime are also incorporated. Age at onset, marital status at onset, years of education, and race are included. The number of dependents is not used although it is important as both a proxy for commitment to the workforce and in computing family disability benefits because it could not be identified accurately from this cross-sectional survey.

Health status variables are incorporated into the analysis. The extent of poor health is closely related to the reduction in work capacity. First, specific health

conditions causing work limitation are controlled for. Instead of listing all 52 health conditions asked in the survey, a worker's main health condition is classified into one of the 3 major groups: cardiovascular, musculoskeletal and all other conditions. All other conditions groups are omitted in the estimation as a reference group. Next, comorbidity, the existence of multiple health conditions as a proxy for the severity of one's health condition, is tested. Mitchell (1986) and Yelin et al. (1986) consider this variable as of the survey date. However in this study, the existence of multiple conditions is considered at the time of the onset of the work limitation.

Human capital variables that are theoretically associated with job turnover are also incorporated into the analysis. Seniority at the onset job, measured in years form the start of the job until the onset of the work limitation, is used as a proxy for specific human capital at the job. Furthermore, total quarters of coverage at all the previous social security insured jobs is available from the earnings history and it is used as a proxy for an "experience" or general human capital variable. While general training raises the marginal productivity of a worker in all firms, specific training increases the marginal productivity only in the firm providing the training. Since human capital theory predicts greater job stability for the worker with specific job training, we expect a negative relationship between the hazard of job exit and the pre-onset job tenure variable, whereas a positive relation with experience is expected because a worker with more experience has more options from which to choose.

Variables related to job characteristics are also incorporated. Several researchers have been interested in testing the relationship between retirement and employment in a physically demanding job. The hypothesis that employment in a physically demanding job reduces the probability of woking will be tested using the proxy variables for physically demanding jobs used in the literature.

First, the usual binary variable representing white/blue collar occupation is used. As an alternative to this occupation variable, a set of occupation characteristics variables are imputed based on the method suggested by Roos and Treiman (1980), and in order to include only job characteristics that may influence the job exit behavior, the two variables-physical demands, and STRENGTH-are applied to our sample and tested in the equation.

Most importantly, the employer's willingness to help impaired workers seems to be a significant factor in delaying work disability. Table 3 provides information on 348 men who suffered a health condition which limited their ability to work on their jobs by the main health condition group. Thirty percent had employers who provided some help so that they could stay at work. Of those workers, 94 percent initially stayed on that job after the onset of this condition, while almost one-half of workers who received no help left their job immediately. Almost two-thirds of workers who received help from their employers were still working as of the survey date, while less than one-half of those who got no help were working. These distinctions were also found among persons with different

[Table 3] Job Exit Behavior by Employer's Help

	All	Group*		
	(n = 348)	CA (n = 75)	MU (n = 152)	OT (n = 121)
			*Percent of Those Who Initially Stayed at Onset Job***	
Help	94%	92%	96%	94%
No Help	54%	52%	56%	54%
All	67%	65%	68%	66%
			*Labor Force Participation rate****	
Help	63%	56%	63%	69%
No Help	43%	16%	59%	37%
All	49%	29%	61%	46%

* Group CA : Workers with cardiovascular conditions
MU : Workers with musculoskeletal conditions
OT : Workers with all other conditions

** It is based on the respondent's answer to the question; 'At the time your helth started to limit your ability to work, did you stay with the same employer?

*** Labor force participation rate as of survey date in 1978.

disease groups. This suggests that an employer's help may be crucial to maintaining disabled workers on the job. However, the employer may be more likely to accommodate disabled workers with more experience, less severe health problem; especially those for whom cost of accommodation is less expensive. In this sense, the 'Help' variable may suffer from a serious endogeneity problem. One solution to this problem is to estimate an equation that assings a probability of getting help to each person. To do this, a probit equation for a probability of help is run with regressors including replacement rate, job tenure, age at onset, non-white, education, white collar, comorbidity, functional limitations in performing job task, cardiovascular, musculoskeletal conditions etc. Then the probability of getting help is calculated based on the estimated probit equation and will be used as instrumental variable in the hazard rate equation.[12] This will be tested in a dynamic model setting.

VI. RESULTS

The empirical model is estimated using a univariate interval hazard model technique. Table 4 presents estimates of the hazard of leaving an employer following the onset of a work limiting health condition. It shows the effect of the time variable as well as those of other explanatory variables. Model 1 and Model 2 offer alter-

[12]See appendix table 1. It turns out that the higher the probability of getting help, the lower the replacement rate and the less severe the health problem. Also white collar workers are more likely to get employer's help.

[**Table 4**] Estimated Hazard of Leaving Onset Job

Explanatory Variables	Hazard		Medel[1]	
	Model 1 No Unmeasured Heterogenity		Model 2 With Unmeasured Heterogeneity	
	Coefficients	t-value	Coefficient	t-value
Constant	−0.837	−1.610	−0.964	−1.260
Expected replacement rate	0.745***	2.719	0.963**	1.934
Age at onset	0.035***	3.274	0.049***	2.898
Married at onset	−0.237	−1.453	−0.365	−1.597
Non-white	0.247	1.353	0.389	1.462
Had savings	−0.008	−0.059	0.043	0.229
Education	−0.023	−0.944	−0.025	−0.753
Help	−1.960***	−4.744	−2.823***	−4.574
Job tenure at onset job	−0.224**	−2.327	−0.353**	−2.522
Experience	−0.003	−0.935	−0.005	−1.009
Occupation				
White collar	−0.130	−0.618	−0.133	−0.469
Health				
Comorbidity	−0.043	−0.283	−0.087	−0.431
Cardiovascular	0.013	0.063	−0.056	−0.189
Musculoskeletal	−0.104	−0.689	−0.117	−0.553
Time	−0.153***	−2.884	0.024	0.237
Time square	0.001**	1.959	0.001	0.068

1. Model 1 was estimated with assumption of no unmeasured heterogeneity, whereas model 2 assumed that this unmeasured heterogeneity term follows a lognormal distribution.
2. ***significant at 1%, **at 5%, *at 10%

native methods of controlling for the heterogeneity: Model 1 assumes that all heterogeneity is controlled by measured socio-economic variables. Model 2 allows for unmeasured heterogeneity but assumes that it follows a lognormal distribution. As can be seen, except for time dependence, the results are very similar.

First, economic incentives do appear to independently affect the decision of a worker to leave the employer. The higher the expected replacement rate, the higher the risk of leaving his onset job. This is consistent with the empirical evidence that Social Security Disability Insurance has been a work disincentive for prime age male workers. Another economic variable, asset position available at onset, is not found to be significant.

As expected, the hazard of leaving the onset job significantly decreases if the employer helps the worker at the workplace. This result seems to strongly support the economic rationale of the Americans with Disabilities Act of 1990. The socio-demographic factors, with the exception of age, are not significant, The hazard of job exit appears to rise with age at onset; the older the onset of a work limitation, the more likely it is that a worker will leave the onset job. Other demographic

factors, which control for marital status, and education, do not show significant effects on the hazard of job exit.

Occupation related variables representing physically demanding jobs also show insignificant effects. This was true whether our measure was a simple binary variable indicating white collar job as shown here or the more sophiscated scales of physical requirements of the job developed by Roos and Treiman (1980). These findings are in contrast to the current empirical evidence found in the work disability literature (Luft 1978, Yelin et al. 1980) or some of the retirement literature (Holden 1988).[13]

We also find that the longer initial job tenure of a worker slows the job exit. This is consistent with the human capital theory that workers with firm-specific experiences will be the last-fired as well as the first-rehired. If both the employer and a worker shared the training costs of the job together, then both parties have an incentive to get along with each other for a long time. On the other hand, we find overall experience in the workforce, measured as total quarters of coverage in the workforce, measured as total quarters of coverage in social security covered jobs, has a negligible effect on the risk of job exit.

It is puzzling that health variables have such negligible effects on the likelihood of leaving a job. The comorbidity variable, as a measure of the severity of health, has an insignificant effect on the hazard of leaving a job. The effect of a specific work limiting condition on the hazard of job exit is also negligible. Compared to the omitted group of those with all other health conditions, workers with either musculoskeletal or cardiovascular conditions seem to have a statistically insignificant effect on the risk of leaving the onset job.

The finding that health variables have negligible effects on the job exit decision over time should be interpreted with care. This may be attributable to a number of factors. First, since the information in the disability survey is only available at two points, the time profile will capture changes linked to individual specific regressors which occur over time. Second, it is possible that the comorbidity variable as a proxy for severity of health might not capture the true extent to which poor health influences the labor force attachment. It would be desirable to have a variable which reflects a worker's functional limitations in performing job tasks. In fact, the function variable is not included in this analysis due to the tautological nature

[13]Quinn(1977), who also found these variables to be insignificant, suggested several reservations about the use of these job attributes. first, a physically demanding job may be desirable to some workers; they may enjoy a job that requires strength or may not be bothered by bad working conditions. Second, those attributes are endongenous to some degree; they were chosen by a worker he accepted the onset job. Also, they may already be compensated for in terms of other fringe benefits. Finally there may be an errors-invariable problem in the DOT classification systems in approximating the true job characteristics.

of the variable.[14] Clearly, due to data limitations, the effect of health variables should be interpreted carefully.

Finally we turn to time dependence. The coefficients on time are expected to capture the true time dependence controlled for the heterogeneity across workers. Model 1, in which only observed heterogeneity is considered, and model 2, in which both measured and unmeasured heterogeneity are controlled, show strikingly different time dependence patterns. In model 1, which the marginal change in the likelihood of leaving the onset job eventually rises, this is not the case in the early periods after the onset of the work limitation. This meas that a health impaired worker might try to adjust to the situation until he settles down, but as he exhausts as his means of adjustment or as his health problem gets more serious, actual risks of leaving the onset job may begin to rise. That is, the estimated time dependence is $\exp(-0.153\ t + 0.001\ t^2)$. Thus the hazard reaches a minimum, other things being equal, at $t = 13.6$. Hence we find that the hazard of leaving onset job for our sample actually falls for 13 years and then rises thereafter. On the other hand, in model 2, the hazard increases monotonically over time, although the time coefficients are not statistically significant. Thus, when unmeasured heterogeneity is controlled for, it is found that the risk of leaving the onset job increases over time as the commitment to work falls but the effect is very small.[15]

VII. MARGINAL IMPACTS OF MAIN VARIABLES ON THE EXPECTED JOB DURATION

Using our estimated model, the effects of some policy measures can be quantified. From the parameters of the hazard model, we can calculate the expected duration(ED) of time before succumbing to the hazard of leaving the onset job. By calculating the expected duration of employment after the onset of a work limitation, we can measure the impact of a main health condition on the years of work at the onset job. Furthermore, marginal impacts on the expected duration, i.e.,

[14]The question in the questionnaire is that "Did having to do any of these things [to walk, stand for long periods, sit for long periods, stoop, crouch or kneel, reach, use fingers to grasp or handle, use eyes for inspection or reading, lift or carry weight up to 10, 25, 50 pounds] interfere with or keep you from working at that job after your health limited your ability to work?" In fact, this function variable has a highly significant effect on the risk of job exit, when included.

[15]Heterogeneity can arise from left-out-regressors, functional form misspecificaiton, from "unobservable" variations in taste. Unless the heterogeneity components are independent of regressors, inferences ignoring heterogeneity can be seriously biased. In this study, I tried several model specifications. The results seemed to be quite robust, at least in terms of major variables of interest-replacement rate, and employer's help-whether or not I assumed unmeasured heterogeneity. More complete research would require the test for the existence of unmeasured heterogeneity. However it will be postponed until future research, since the main purpose of this study is to test how sensitive a worker's decision on job exit is to the employer's help.

[Table 5] Marginal Impacts of Main Variables on the Expected Duration at Onset Job

Explanatory Variable	Mean	Marginal Impact (years)	t-Values
Help*	0.3	5.50	4.22
Expected Replacement rate*	0.3	−2.09	−2.71
Age at onset*	39.8	−0.09	−3.02
Job tenure at onset job* until onset	9.7	0.63	2.27

*Marginal impacts were calculated based on 1 unit increase of expected replacement rate, and 1 year increase in age, and job tenure until onset. In case of Help, note that the probability of getting help is increased from zero to one to obtain marginal impact, which virtually means comparing the case of no help and help.

first dirivatives, with respect to continuous explanatory variables can be calculated as d(ED)/dx. And the effect of a dummy variable, d, is computed as ED(d = 1)-ED(d = 0). Also, the elasticities on the expected duration with respect to any explanatory variables can be calculated based on the marginal impacts at the selected value of each explanatory variable.

Table 5 shows the marginal impacts of the main variables on the expected tenure at the onset job. The calculated expected duration of employment after onset at the mean values of all expanatory variables is 2.9 years. It turns out that, other things being equal, the employer's help at the workplace has the largest marginal impact on the expected tenure at the onset job once a work limitation has occurred, and increases in the expected replacement rate also has a substantial.

An accommodation of the impaired worker seems to be an important policy in affecting the behavior of workers with health limitation. It is found that those who got help might stay at the onset job longer than those without help by 5.5 years. According to my results, it appears that the employer's help is a very important measure of lengthening the work life of a health impaired worker. This finding suggests that the recent federal legislation, which requires accommodation for the disabled at the workplace, may now have a good economic rationale for it.

The importance of this policy parameter is even better seen when compared to the policy parameter most often measured in disability studies-the expected replacement rate. Using the same mean values for all other variables, we measure the effect of a change in the expected replacement rate from zero to one. This dramatic policy counterfactual which captures the full effect of a guaranteed total replacement of wages for the mean worker reduces the expected duration by 2.1 years. This value is approximately the half of the estimated effect of accommodation. However, it is unlikely that the expected replacement rate will ever be allowed to fluctuate to this degree. Hence accommodation appears to be a more realistic and powerful tool for affecting work than does the replacement rate. Also it was found that one year increase in the age at onset will shorten the expected duration

by 0.1 years or 1.2 months, whereas having one more year of tenure would lengthen the expected duration by 7.2 months.

VIII. CONCLUSION

The analysis presented in this study not only confirms the findings of other studies but also documents new evidence on the impact of work disability. In this paper, I introduced dynamic tools in interpreting the pattern of the job exit decision of a health impaired worker. In particular, the time pattern and hazard of leaving job after a work limitation occurred have been analyzed by continuous time hazard model technique.

Here we show that 30 percent of the disabled males in the sample were accommodated by their employers at the time they suffered a work limiting health condition. And more importantly, we show that such help significantly increased these worker's expected job tenure. The mean worker's expected tenure increased substantially through accommodation by 5.5 years. A marginal increase in accommodation more than offsets a marginal change in expected replacement rate for the mean worker. Thus accommodation appears to have a substantially greater potential for increasing duration than would decreases in the expected replacement rate, since it is unlikely that dramatic drops in expected DI benefits are politically acceptable.

Public policy toward disability has emphasized interventions at the level of the individual rather than at the level of the workplace. The Americans with Disabilities Act of 1990 was one of the efforts to reverse this trend. If we can encourage employers to hire the disabled or to change facilities in order to keep health impaired workers on the job, then we can raise the efficiency of other social programs by adjusting social costs of medical intervention or social interventions such as vocational rehabilitations. To encourage this practice, policies such as wage subsidies or tax credits to offset the costs of accommodating the disabled may be employed, although they might have a distortionary welfare effect on the other areas of the economy.

APPENDIX

[Table 1] Probit Model for Probability of Getting Help(First Stage to Obtain Instrument for Help)

Variables	HIS SAMPLE	
	coefficients	t-value
Constant	−0.234	−0.596
Replacement rate	−0.692*	−1.908
Age at onset	−0.023	−0.196
Nonwhite	0.158	0.821
Job tenure	−0.035	−0.035
Experience	0.009	0.026
White collar	0.034*	1.782
Comorbidity	0.001	0.006
Function problem	−0.301**	−2.061
Cardiovascular	0.136	0.650
Musculoskeletal	0.105	0.622
Log-likelihood	−208.0	

**significant at 5% *at 10%

REFERENCES

AMEMIYA, T. (1985), *Advanced Econometrics,* Oxford:Basil Blackwell.

ALLISON, P.D. (1982), "Discrete-time Methods for the Analysis of Event Histories," in *Sociological Methodology* ed by Leinhardt S., San Francisco: Jossey-Bass: pp. 61-98.

ALLISON, P.D. (1984), *Event History Analysis: Regression for Longitudinal Event Data,* Beverly Hills, Calif: Sage.

BOUND, J. (1989), "The Health and Earnings of Rejected Disability Insurance Application," *American Economic Review,* June: pp. 482-503.

BURKHAUSER, R.V. (1990), "Mortality on the Cheap: The Driving Force Behind the Americans with Disability Act," *Regulation,*(Summer) Vol 3. No.2: pp. 47-56.

BURKHAUSER, R.V. and HAVEMAN, R. (1982), *Disability and Work: The Economic American Policy.* Baltimore: Johns Hopkins Press.

BUTLER, J.S. (1990), "Hazard Models, Competing Risks, and Unmeasured heterogeneity," mimeo.

BUTLER, J.S, ANDERSON, K.H. and Burkhauser, R.V. (1989), "Work and Health After Retirement: A Competing Risks Model with Semiparametric Bivariate Interval Hazard Model," *Review of Economics and Statistics* Feb: pp. 46-53.

BYE, B. and SCHCHTER, E. (1982), *1978 Survey of Disability and Work: Technical Introduction,* Jan.

HALPERN, J. and HAUSMAN, J. (1986), "Choice under Uncertainty: Labor Supply and Application for the SSDI Program" In *Unemployment, Search and Labor Supply* ed. Blundell, R. and Walker, I. Cambridge: pp. 294-302.

HECKMAN, J. and SINGER, B. (1985), "Social Science Duration Analysis", in *Longitudinal Analysis of Labor Market Data*, eds. Heckman, J and Singer, B. pp. 39-110, Cambridge University press.

HOLDEN, K.C. (1988), "Physically Demanding Occupations, Health, and Work after Retirement: Findings From the New Beneficiary Survey", *Social Security Bulletin,* November, pp. 3-15.

KIM, Y.W. (1990) "The Influence of Health on Work: A Dynamic Analysis of the Timing of the Job Exit and Disability Insurace Application" unpublished ph.D. Dissertation, Vanderbilt University.

LEONARD, J. (1979), "The Social Security Program and Labor Force Participation," NBER Working Paper, #392.

LUFT, H. (1975), "The Impact of poor Health on Earnings," *Review of Economics and Statistics* 57: 43-57.

MITCHELL, J, (1986), "A Life Cycle Model of Arthritis and Labor Supply," in unpublished ph. D. dissertation, Vanderbilt University.

PARSONS, D. (1980a), "The Decline in Male Labor Force Participation," *Journal of Political Economy,* 88: pp. 117-134.

PERSONS, D. (1980b), "Recent Trends in Male Labor Force Participation," *American Economic Review,* 70: pp. 911-920.

QUINN, J.F. (1977), "Microeconomic Determinants of Early Retirement: A Cross-sectional View of White Married Men," Journal of Human Resources, Summer: pp. 329-346.

ROOS, P.A. and TREIMAN D.J. (1980), "DOT Scales for the 1970 Census Classification," in *Work, Jobs, and Occupations* eds by Miller, A.R., Treiman D.J., Cain P.S., and Roos P.A., National Academy Press, Washington, D.C: pp. 336-389.

YELIN, E., NEVITT, M., and EPSTEIN, W. (1980), "Toward an Epidemiology of Work Disability," *Millbank Memorial Fund Quarterly,* 58, 3, pp. 386-415.