Severity of Work Disability and Work in Australia*

UMUT OGUZOGLU

Department of Economics, University of Manitoba, Canada

and IZA, Bonn

*This paper uses the confidentialised unit record file of the Household, Income and Labour Dynamics in Australia (HILDA) survey. The HILDA Survey project was initiated and is funded by the Australian Department of Family and Community Services (FaCS) and is managed by the Melbourne Institute of Applied Economic and Social Research. The findings and views reported in this paper, however, are those of the authors and should not be attributed to either FaCS or the Melbourne Institute. This study is partially funded by ARC grant (#DP0663362).

Abstract:

At any given time, individuals may be subject to health shocks whose impact on work capacity can vary in magnitude. Therefore the variation in severity levels can explain changes in labour force decisions that cannot be picked up by the general disability status alone. This paper analyses the effect of severity of disability on labour force participation by using two measures of severity: the self-reported work limitation scales and the SF-36 physical component summary scores. Using first five waves of the Household, Income and Labour Dynamics in Australia Survey, several static and dynamic panel data models are estimated to account for state dependence and unobserved heterogeneity in participation. The results suggest that differences in severity levels explain a significant portion of the variance in the participation rates among disabled individuals. It is also found that severe work limitations have a more immediate impact on individuals' labour force outcomes. Moreover, the disabilities are shown to have longer lasting adverse effects on female participation.

1. Introduction

This paper analyses the role of the severity of work limitations on labour force participation by using five waves of the Household, Income and Labour Dynamics in Australia (HILDA) Survey. The main advantage of the HILDA survey is that both self reported work limitations and more 'objective' health measures based on detailed health questions are provided. The aim of this paper is to stress the importance of treating the disabled population as a heterogenous group and to provide a sensitivity analysis of different definitions of severity. Several static and dynamic panel data models are estimated to allow for unobserved heterogeneity, state dependence in labour force participation, and heterogeneity in the severity dimension.

At any given time, individuals may be subject to health shocks whose impact on work capacity can vary in magnitude. Therefore, variation in severity levels can explain changes in labour force participation decisions that can not be picked up by general disability status alone. As Bound *et al*. (1995) pointed out; ignoring the distinction between people with some limitation and people who are incapable of work disregards an important dimension of disability. For severely limited individuals, not to participate in the labour force may not be a choice but an absolute requirement of their health condition. Therefore, standard labour force analysis of the disabled where disability is identified with a single dummy variable may omit important information hidden in the severity dimension. There is international evidence on the impact of severity of functional disability (i.e. limitation in daily activities) on labour force outcomes (Hum and Simpson (1998), Wilkins (2002), Gannon (2004), Jones and Latreille (2007)). However, studies that employ the severity of work limitation directly are rare. O'Donnell (1998) controls for incapacity to work explicitly by a latent index of capacity, specified to be a linear function of observed characteristics. Jones (2006) reports that for the work limited individuals, severity, as measured by the number of health problems, is strongly significant and negative in the probit model of employment status. In this paper, I use self-reported work limitation scales to separately identify individuals who cannot work and those with less severe work limitations.

This study also looks at the sensitivity of the findings to the choice of the severity measure. There is growing disagreement on the reliability of self-reported work limitations. Although some studies are confident with the work limitation measure (Stern (1989), Dwyer and Mitchell (1999), Benitez-Silva *et al.* (2004), Cai (2007)) other research presents concerns about misreporting due to psychological, social and economic incentives that leads to the 'justification bias' (Kerkhofs and Lindeboom (1995), Kreider (1999), Kreider and Pepper (2007)). Namely, since ill health is one of the most socially acceptable reasons to exit work, individuals may report health problems in order to justify their labour market performance. In this paper, in addition to the self-reported work limitation, a 'global disability' measure based on SF-36 health status questions is used. This approach was recently employed by Jones and Latreille (2007) to define severity of global disability on the premise that the global disability, which potentially encompasses more than just work limitations, may be less problematic. Additionally, global disability categories are based on detailed (albeit self-reported) information on health status and therefore can be more objective than self-reported work limitation. A global health measure, however, is less than perfect. First, since it is obtained from the survey data it is potentially influenced by the same unobserved factors that drive work limitation reports and therefore it may not be a purely objective measure. Second, even an objective measure of health can be a poor proxy of work capacity (Bound 1991). The approach taken in this paper is to estimate the relationship between severity and labour force participation using self-reported work limitations and global disability separately, and to observe the sensitivity of this relationship to the choice of disability measure.

The remainder of the paper is organised as follows: the second section introduces the data source and describes the sample used; the third section details the construction of the severity measures and discusses their relationship with labour force participation rates. The fourth section introduces the econometric model; the fifth section compares estimates from several panel data models; finally, section six concludes.

2. Data and Sample Selection

The data used for this paper come from the first five waves of the Household, Income and Labour Dynamics in Australia (HILDA) Survey. Details of this survey are documented in Watson and Wooden (2004). In the first wave, 7,683 households representing 66 percent of all in-scope households were interviewed, generating a sample of 15,127 persons who were at least 15 years old and eligible for interviews, of whom 13,969 were successfully interviewed. Subsequent interviews for later waves were conducted one year apart. In addition to the data collected through personal interviews, each person completing a personal interview was also given a self-completion questionnaire to be returned upon completion by mail or handed back to the interviewer at a subsequent visit to the household. The HILDA attrition rates for waves 2, 3 and 4 were 13.2 percent, 9.6 percent and 8.4 percent respectively, which is not much higher than other longitudinal surveys. The proportion of Wave 4 respondents who were successfully interviewed in Wave 5 is 94.4%.

The HILDA survey contains detailed information on each individual's labour market activities and history. Socio-demographic characteristics of the respondents and information indicating health status are also recorded. In each wave, respondents are asked the following question to assess if they have a long-term health condition: *"...do you have any long-term health condition, impairment or disability that restricts you in your everyday activities, and has lasted or is likely to last, for 6 months or more?"*

While this question is asked, specific examples of "long-term health conditions" were shown on a card. These include, among many others, limited use of fingers or arms, or problems with eyesight that could not be corrected with glasses or contact lenses. Furthermore, individuals with long term health conditions are also asked if their condition is work limiting. (*"Does your condition limit the type of work or the amount of work you can do?")*. Finally, the degree (or severity) of work limitation are identified using the following HILDA questions "*[...] could you pick a number between 0 and 10 to*

indicate how much your condition(s) limit(s) the amount of work you can do", where 10 indicates that they cannot work.

In addition to the information collected from the face-to-face interviews, HILDA contains more detailed questions, such as Short Form 36 health status questions (SF-36), in the self-completed questionnaire. The survey items in the SF-36 are scored such that 8 scale scores are given: physical functioning, role physical, bodily pain, general health perceptions, vitality, social functioning, role emotional, and mental health. Two summary measures can be calculated from these scales – these are called the physical component score (PCS) and the mental component score (MCS). PCS summary and the health indices that form PCS have been shown to be the most valid SF-36 scales for measuring physical health (Ware et al., 2000).

The sample used in this study contains men between 24 and 64 years of age and women between 24 and 60 years of age at the time of the interview. Young people in full time study, older people who are eligible for Old Age Pension (age 65 for men and age 60 for women) and anyone with missing data points are excluded from the analysis. The final sample consists of a balanced sample of 2200 male and 2368 female respondents that were observed for the first five waves of HILDA. Table 1 describes the demographic characteristics of the sample.

Table 1: Mean Values of the Demographic Variables

Variable Name	Definition	MEN	WOMEN
age	Age	44.87	42.56
age2	Age squared	2106.5	1882.5
atsi	=1 if Aboriginal and Torres Strait Islander	0.01	0.01
nesb	=1 if from Non English Speaking Background	0.10	0.11
mcity	=1 if lives in a major city	0.60	0.61
bachplus	=1 if has Bachelor or higher degree	0.25	0.27
mar	=1 Married or in a de facto relationship	0.79	0.75
kid014	=1 if has children between age 0-14	0.40	0.49
mark014	=1 if married and has a children between age 0-14	0.39	0.41
othinc	Other Household income (Total household gross income minus total gross personal income)	27916.2	49175.1
prtinlf	=1 if partner is a labour force participant	0.54	0.63
Sample Size		8796	9476
No. of Individuals		2200	2368

Note: Above figures are obtained from the pooled sampled of all five waves of HILDA. See Table 2 for the distribution of the disability categories.

3. Severity Measures and Labour force Participation

In this paper, two separate measures of severity are used. The first measure utilises self-reported work limitation scales. I follow Shields *et al.* (2007) to create three mutually exclusive severity categories as follows: those who could not work are labelled as severely work limited. Individuals with a disability that is not work-limiting are categorised as mildly work limited. All other respondents, with reported work limitation scale 1 to 9, are classified as moderately limited. The second set of categories is based on the PCS scores and aims to capture the severity of global disability (not only work related). The PCS scores are calculated by factor analysis using four health indices (physical functioning, role-physical, bodily pain and general health) derived from SF-36 health questions. The PCS score is scaled so that it has a mean of 50 and a standard deviation of 10. The scaling uses population weights to reflect the health status of the Australian adult population. Recently, Jones and Latreille (2007) form severity categories using PCS based on the thresholds introduced by Sanderson and Andrews (2002)[1]. Individuals with a PCS score above 50 were considered as not disabled, mild disability was represented by a score between 40 and 49, moderate disability 30 to 39 and severe disability a score below 30. I use these thresholds with only slight modifications.[2]

Table 2 compares the work limitation and the global disability using a pooled sample of five waves. A comparison of the row and the column totals show that both no disability and severe disability are estimated at similar rates by work limitation and global disability measures. Close to 90 percent of individuals who report no disability are also considered as globally not disabled. Similarly, the majority of mildly work limited individuals appear to be not disabled when the global disability measure is used. Looking at the moderate work limitation category, 40 percent of men and 45 percent of women from this limitation group have only mild global disabilities. Moreover, approximately 20 to 22 percent of the moderately work limited people have no global disabilities. Finally,

[1] Unlike this paper and Jones and Latreille (2007), the focus of Sanderson and Andrews (2002) is explicitly the mental disability. Therefore, the thresholds are originally created to define severity categories using the mental component summary (MCS) as opposed to PCS that is used here.

[2] A threshold of 31 is used for the severe disability category in order to gain sufficient sample size for this group.

the majority of the severely work limited individuals would be considered as moderately disabled by the global measure.

Table 2: Work Limitation and Global Disability

			MEN		
Global Disability / *Work Limitation*	*Not Disabled*	*Mild*	*Moderate*	*Severe*	*Total*
Not Disabled	87.48	11.6	0.91	0*	75.58
Mild	68.21	27.69	3.88	0.22*	8.44
Moderate	22.57	39.54	33.94	3.95	14.95
Severe	8.85*	26.55	50.44	14.16*	1.03
Total	75.34	17.29	6.61	0.75	
			WOMEN		
Global Disability / *Work Limitation*	*Not Disabled*	*Mild*	*Moderate*	*Severe*	*Total*
Not Disabled	85.09	13.5	1.4	0.02*	80.32
Mild	63.13	30.99	5.74	0.14*	5.88
Moderate	19.47	44.78	33.1	2.66	13.01
Severe	10.75*	13.98*	52.69	22.58	0.79
Total	74.67	18.6	6.18	0.55	

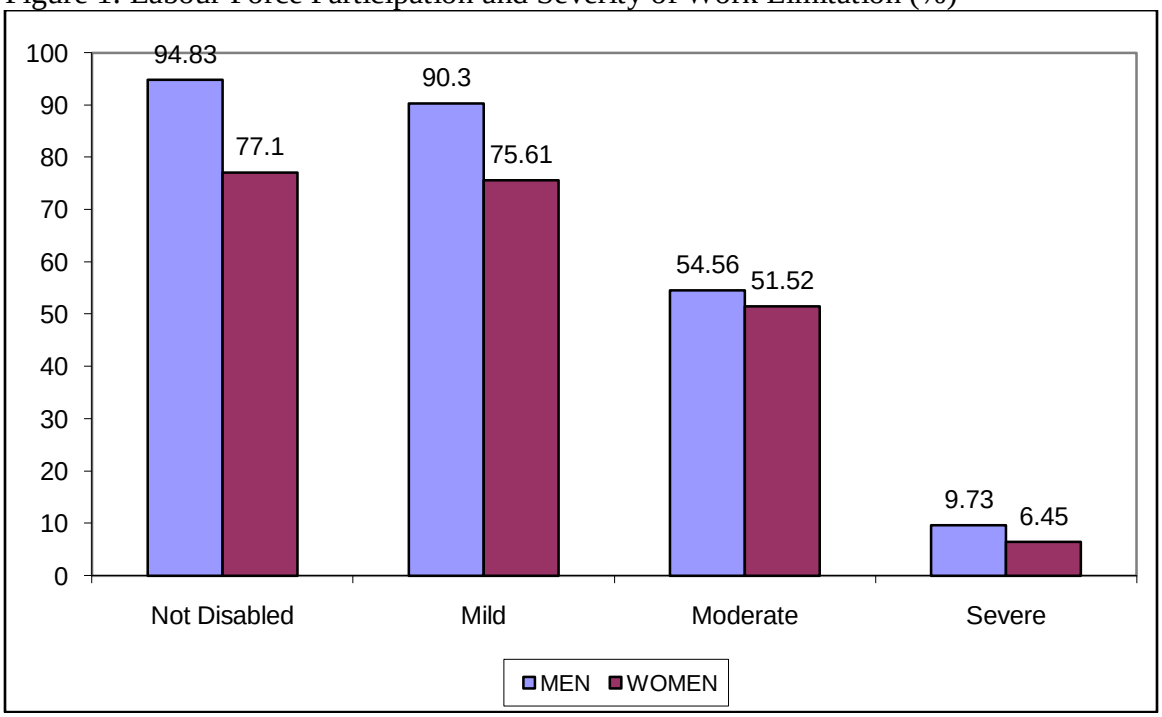
Note: *indicates less than 20 observations.

Figure 1 and 2 present labour force participation rates by severity using work limitation and global disability respectively. It is apparent that, for both measures, ill health is associated with worse labour force performance. For example, compared to 95 percent of not disabled men, only 54 percent of the moderately work limited and 9.7 percent of the severely work limited men are labour force participants. Similarly, compared to 77 percent of not disabled women only about 51 percent of moderately work limited and about 6 percent of the severely work limited women participate in the labour force[3]. In Figure 1, it can be seen that the mildly work limited people are largely indistinguishable from their not disabled counterparts. Another interesting feature is that the gender participation gap appears to be shrinking in severity.

[3] The participation rates for the severely work limited individuals appear to be high given that this category contains individuals who self-reportedly cannot work. Measurement error may be the most likely reason. In Appendix B, Table A2 gives further details such as working hours and employment status for the work limited individuals.

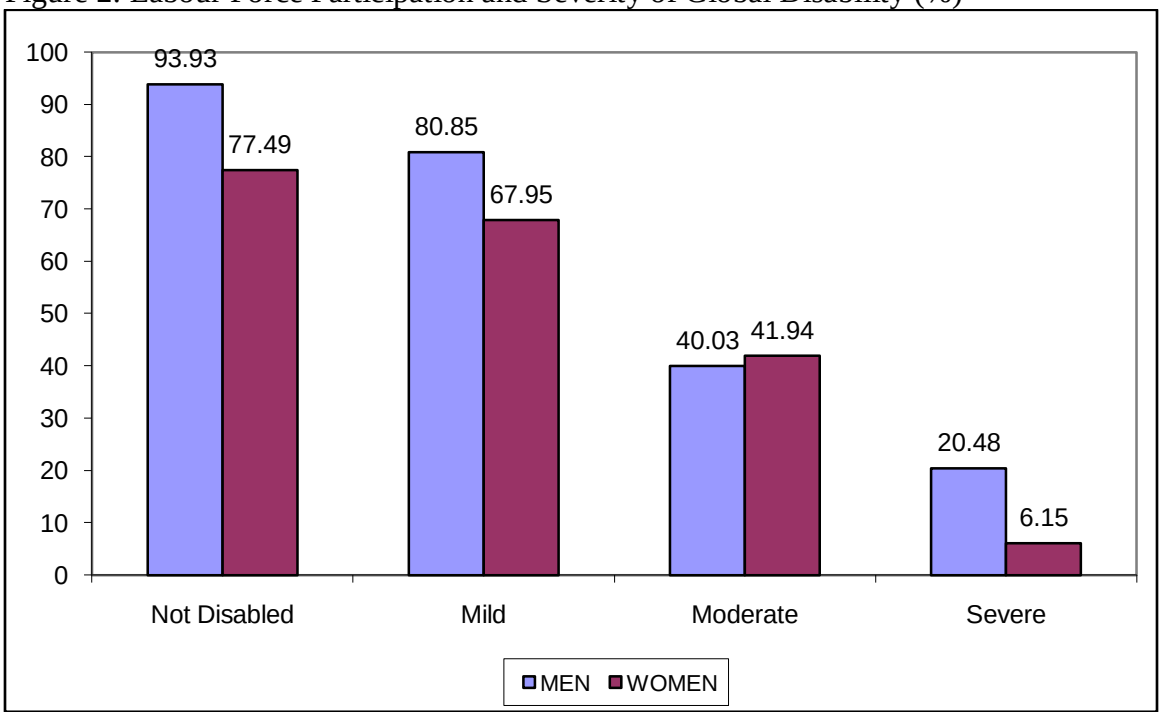
For the 'Not disabled' category the participation rates are very similar across different measures of disability. For mild and moderate disabilities, however, the global disability groups exhibit lower (by about 10 percent) participation rates compared to the work limitation groups. This may be due to the cut off points that are used to create global disability categories suggesting that a moderately disabled person, in the global disability sense, may suffer from more severe work limitations than a moderately work limited person. Finally, the difference in participation rates of severely work limited and (globally) severely disabled men is remarkable. Although there are very similar participation rates among severely disabled women using either definition of disability, the results for men are considerably dissimilar**.** Compared to 9.7 percent of severely work limited men, about 20 percent of individuals with severe global disabilities participate in labour force.

Figure 1: Labour Force Participation and Severity of Work Limitation (%)



Note: Figures are obtained using a pooled sample of waves 1 to 5 of HILDA. The severity levels are based on self-reported work limitation scales.

Figure 2: Labour Force Participation and Severity of Global Disability (%)



Note: Figures are obtained using a pooled sample of waves 1 to 5 of HILDA. The severity categories are based on SF-36 physical component summary (PCS).

In Table 3, the transitions across severity of work limitation from one year to the next are reported[4]. We see a considerable asymmetry in the level of persistence across severity levels. For both men and women having no disability in one period is strongly associated with no disability in the next period. Approximately 90 percent of the individuals without a disability do not report a change in their disability status in the next year. People who report a disability vary considerably within the severity levels in terms of their transition rates. The majority of the individuals with not-work-limiting disabilities (the mildly work limited group) move into the not disabled category within a year. On the other hand, about 16 to 17 percent of this group report worsening work limitation in the next period. Moreover, close to one half of the individuals with severe work limitation report moderate limitation in the next period[5]. Furthermore, about 40 percent of this group continue to report severe limitation in the next wave. There is also movement out of

[4] Transitions across waves using severity of global disability are reported in Appendix A.

[5] One possible reason behind the relatively large movements into the moderate category may be related to how this category is created. The current definition of moderate category creates a considerably large cell by combining all people with work limitation scaled 1 to 9. However, splitting the moderate category requires an arbitrary threshold.

severe limitations. Table 2 shows that the majority of individuals with severe work limitations move into the moderate limitation category in the next wave. It appears also that there are transitions into the least severe limitation categories (mild and no disability) from the severely limited group, however the cell sizes in these groups are too small to be reliable.

The results in Table 3 are consistent with findings in Gannon (2004), Kapeteyn *et al.* (2006) and Oguzoglu (2007) where self-reported disability is reported to have significant over time variation. Given the evidence of dynamics within severity levels it is valuable to investigate the labour market performance for those whose work capacity improves or deteriorates over time.

Table 3: Transition across Severity of Work Limitation over Time (%)

MEN				
Status at t / *Status at t-1*	Not Disabled	Mild	Moderate	Severe
Not Disabled	89.3	5.83	4.7	0.18
Mild	48.9	34.12	16.16	0.83
Moderate	18.2	8.27	68.79	4.73
Severe	12.82*	1.28*	55.13	30.77
WOMEN				
Status at t / *Status at t-1*	Not Disabled	Mild	Moderate	Severe
Not Disabled	90.73	4.38	4.76	0.13
Mild	56.39	27.63	15.6	0.38
Moderate	21.15	9.1	66.64	3.12
Severe	7.58*	3.03*	46.97	42.42
ALL PERSONS				
Status at t / *Status at t-1*	Not Disabled	Mild	Moderate	Severe
Not Disabled	90.06	5.06	4.73	0.15
Mild	52.07	31.37	15.92	0.64
Moderate	19.63	8.67	67.75	3.95
Severe	10.42*	2.08*	51.39	36.11

Note: The figures above are obtained using a balanced sample of waves 1 to 5 of HILDA.
* indicates less than 20 observations

4. Model Specification

The model that represents the labour force status of an individual *i* at time *t* can be expressed as follows:

$$y^{*}_{it} = \gamma y_{i,t-1} + X'_{it}\beta_1 + \delta_{1j}\sum_j S_{itj} + \delta_{2j}\sum_j S_{it-1,j} + \alpha_i + \varepsilon_{it} \qquad (1)$$

$$y_{it} = 1[y^{*}_{it} > 0]$$

$$i = 1,\ldots,N\ ;\ t = 1,\ldots,T\ ;\ j = \textit{severe, mild, moderate.}$$

Where y_{it} is a dummy variable that is equal to one when the individual is a labour force participant, X_{it} is a vector of observed characteristics (see Table 1 for the complete list of control variables). The direct effect of the past participation on the current participation is captured by the lagged dependent variable $y_{i,t-1.}$ The work limitation status of individual *i* is represented by a set of dummy variables, S_{itj} , where S_{itj} is equal to 1 if individual *i* at time *t* has a work limitation *j* (e.g. severe, mild or moderate). Similarly, the last period's work limitation status is captured by $S_{it-1,j}$. The time constant individual specific factors that are not observed by the data are assumed to be captured by α_i which is normally distributed with mean zero and variance σ^2_{α}. Finally, the random disturbance term ε_{it} is assumed to be distributed standard normal.

One caveat with the random effect assumption is that the unobserved heterogeneity should be assumed to be uncorrelated with the observed characteristics of the model. In order to relax this assumption the time averages of all time varying variables are added in to the model as additional regressors as in Mundlak (1978).

Another complication with the estimation of model (1) is due to the 'initial conditions problem'. Due to the dynamic nature of the model (1), current labour force participation status depends on the initial labour force status which –for most of the individuals in the sample- predates the start of the data collection and, therefore, is unknown. Treating

initial conditions as exogenous variables leads to inconsistent model estimates. Wooldridge (2005) suggests that consistent parameters can be obtained if one forms the likelihood function conditional on the initial observation of the dependent variable, y_{i1}. This method requires the inclusion of the dependent variable from the first wave as an explanatory variable. The main advantage of this approach is that estimation can be carried out using standard panel probit procedures in existing software such as Stata.[6]

5. Results

This section includes estimation results from the labour participation model (1). Two version of the model (1) are estimated for men and women separately. First, I estimate the model by ignoring state dependence (i.e. $\gamma = 0$). This static model ignores the possibility that low participation rates of disabled individuals can be partly related to their participation status of the past, rather than being directly attributable to their current health conditions. Second, the dynamic models explicitly control for state dependence by including lagged participation. Table 4 and 5 present the estimates from the panel data models by using work limitation and global disability categories respectively. In Table 4, the effects of current work limitations are negative and strongly significant. For men, even those with mild limitations are adversely affected by their disability. This finding is consistent with Gannon (2004) where disabled men with no limitations in daily activities are reported to perform worse in the labour market than comparable non-disabled men. The static model suggests that past disabilities have a direct negative effect on current labour force participation. Both men and women with severe and moderate work limitations in the previous period have lower likelihood of participation than those without past work limitations. After controlling for participation in the previous year the significance of past work limitations disappear for men. The dynamic model for men suggests that the effect of past work limitations is only indirect and alter the likelihood of current participation via lagged participation. For women, however, severe and moderate

[6] An alternative approach, suggested by Heckman (1981), is to approximate the initial conditions by a static probit equation using information from the first wave. The dynamic model (1) and the static model can then be jointly estimated to obtain consistent estimates. The Heckman method is computationally more demanding than the Wooldridge approach and it ran into convergence problems when it was employed to estimate model (1).

work limitations of the past period are still significant even after the lag participation is controlled for in the dynamic model.

Table 5 presents the results when global disability categories are used. The results generally agree with the figures presented in Table 4. The current and past disabilities are significant in the static model for both men and women. However, past disabilities, except for severe disabilities, are significant only for women when the dynamic model is used. The lack of precision of the past severe disability variable may be due to the small sample size of this group.

The effect of control variables is generally as expected and robust across models. A bachelor or higher degree increases the likelihood of participation. Living in a major city is associated with higher likelihood of participation for men but it seems not to be important for women. Coming from an Aboriginal of Torres Strait Islander (ATSI) or non-English background negatively affects women's labour market outcomes. Having children aged 0 to 14 decreases the likelihood of female participation but does not affect men's participation. Both men and women are more likely to participate in the labour force if their partners are also participants. Other family income, however, does not effect labour force decisions. Also robust across the models is the degree of persistence in labour force participation. Consistently with Gannon (2004), Kapeteyn *et al* (2006) and Oguzoglu (2007), participation in the labour force in one period significantly increases the likelihood of participation in the future period.

Table 4: Panel Data Model Estimates, Work Limitation

	MEN				*WOMEN*			
	Static Model		*Dynamic Model*		*Static Model*		*Dynamic Model*	
	Coef.	*S. E.*	*Coef.*	*S.E.*	*Coef.*	*S.E.*	*Coef.*	*S. E.*
Constant	2.72**	0.32	-0.61**	0.20	1.01**	0.28	-1.11**	0.14
LF_{t-1}			1.29**	0.10			1.13**	0.06
Work Limitation								
$Severe_t$	-3.13**	0.35	-2.43**	0.27	-2.79**	0.45	-2.05**	0.37
$Moderate_t$	-1.57**	0.12	-0.99**	0.09	-0.75**	0.10	-0.43**	0.08
$Mild_t$	-0.41*	0.15	-0.26*	0.12	-0.08	0.12	-0.01	0.09
$Severe_{t-1}$	-1.78**	0.36	-0.44	0.29	-2.56**	0.54	-1.18**	0.41
$Moderate_{t-1}$	-1.00**	0.12	-0.17	0.10	-0.73**	0.10	-0.29**	0.08
$Mild_{t-1}$	-0.09	0.14	0.04	0.12	-0.24	0.12	-0.14	0.10
Controls								
age	0.12*	0.04	0.06	0.03	0.37**	0.03	0.19**	0.02
age2	0.00**	0.00	0.00**	0.00	-0.01**	0.00	0.00**	0.00
atsi	-0.45	0.63	-0.01	0.37	-1.52**	0.43	-0.49*	0.20
nesb	-0.29	0.21	-0.23	0.12	-0.45*	0.17	-0.07	0.08
mcity	0.95**	0.33	0.65*	0.27	-0.05	0.20	0.01	0.18
bachplus	6.55**	1.42	3.85**	0.87	1.17*	0.58	0.95*	0.47
mar	-0.10	0.31	-0.09	0.26	-0.32	0.25	-0.31	0.20
kid014	-0.53	0.40	-0.26	0.31	-1.25**	0.22	-0.90**	0.16
mark014	0.42	0.39	0.26	0.28	-0.04	0.20	0.00	0.12
lothinc	-0.02	0.02	-0.02	0.02	-0.02	0.02	-0.01	0.01
prtinlf	0.55**	0.16	0.43**	0.14	0.58**	0.14	0.48**	0.12
Initial LF			1.41**	0.12			1.37**	0.08
Time Averages								
age	-0.03	0.03	0.00	0.03	-0.11**	0.02	-0.07**	0.02
bachplus	-6.03**	1.42	-3.71**	0.88	0.11	0.59	-0.58	0.47
mcity	-0.59	0.36	-0.48	0.28	0.01	0.23	-0.03	0.18
mar	0.80	0.40	0.42	0.30	-1.17**	0.37	-0.32	0.24
kid014	-0.03	0.32	-0.01	0.24	-0.34	0.20	0.52**	0.14
lothinc	-0.05	0.03	-0.01	0.02	0.01	0.03	0.01	0.02
prtinlf	1.12**	0.25	0.18	0.18	0.93**	0.26	-0.04	0.16
σ_α	1.74**	0.07	0.64**	0.04	2.09**	0.07	0.68**	0.03
Log Likelihood	-1496.51		-1257.01		-3398.38		-2885.11	

Note: * and ** indicates significance at 5 % and 1 %. LF_{t-1} refers to the labour force participation in the previous wave. Age is scaled to have a minimum of zero. Lothinc refers to the natural logarithm of other household income.

Table 5: Panel Data Model Estimates, Global Disability

	MEN				*WOMEN*			
	Static Model		*Dynamic Model*		*Static Model*		*Dynamic Model*	
	Coef.	*S. E.*	*Coef.*	*S.E.*	*Coef.*	*S.E.*	*Coef.*	*S. E.*
Constant	2.74**	0.32	-0.70**	0.20	1.04**	0.28	-1.10**	0.14
LF_{t-1}			1.35**	0.09			1.14**	0.06
Global Disability								
$Severe_t$	-2.71**	0.40	-1.74**	0.33	-4.68**	1.16	-2.91**	0.75
$Moderate_t$	-2.00**	0.16	-1.25**	0.12	-1.32**	0.14	-0.83**	0.10
$Mild_t$	-0.79**	0.10	-0.49**	0.08	-0.36**	0.08	-0.20**	0.06
$Severe_{t-1}$	-1.25**	0.36	0.09	0.30	-2.04**	0.72	-1.03	0.61
$Moderate_{t-1}$	-1.14**	0.15	-0.10	0.13	-0.82**	0.13	-0.29*	0.10
$Mild_{t-1}$	-0.42**	0.10	-0.09	0.08	-0.29**	0.08	-0.15*	0.06
Controls								
age	0.09*	0.04	0.05	0.03	0.37**	0.03	0.19**	0.02
age2	0.00**	0.00	0.00**	0.00	-0.01**	0.00	0.00**	0.00
atsi	-0.42	0.65	-0.01	0.37	-1.54**	0.44	-0.47*	0.20
nesb	-0.29	0.22	-0.21	0.12	-0.39*	0.18	-0.04	0.08
mcity	0.70*	0.33	0.55*	0.26	-0.04	0.20	0.03	0.18
bachplus	7.08**	1.47	4.11**	0.88	1.16*	0.57	0.95*	0.46
mar	0.03	0.31	0.01	0.26	-0.21	0.25	-0.26	0.20
kid014	-0.60	0.41	-0.21	0.31	-1.24**	0.22	-0.89**	0.16
mark014	0.39	0.40	0.23	0.28	-0.04	0.20	0.00	0.12
lothinc	-0.02	0.02	-0.02	0.02	-0.02	0.02	-0.02	0.01
prtinlf	0.52**	0.16	0.40**	0.13	0.58**	0.14	0.50**	0.12
Initial LF			1.46**	0.12			1.38**	0.08
Time Averages								
age	-0.01	0.03	0.01	0.03	-0.11**	0.02	-0.07**	0.02
bachplus	-6.47**	1.47	-3.94**	0.88	0.11	0.59	-0.60	0.46
mcity	-0.36	0.35	-0.41	0.27	0.02	0.23	-0.03	0.18
mar	0.71	0.40	0.32	0.30	-1.24**	0.37	-0.35	0.24
kid014	0.10	0.32	-0.01	0.23	-0.32	0.21	0.55**	0.14
lothinc	-0.05	0.03	-0.01	0.02	0.01	0.03	0.02	0.02
prtinlf	1.26**	0.25	0.25	0.17	0.93**	0.26	-0.07	0.16
σ_α	1.82**	0.06	0.65**	0.04	2.13**	0.07	0.68**	0.03
Log likelihood	-1545.62		-1300.20		-3389.57		-2873.02	

Note: * and ** indicates significance at 5 % and 1 %. LF_{t-1} refers to the labour force participation in the previous wave. Age is scaled to have a minimum of zero. Lothinc refers to the natural logarithm of other household income.

Average Partial Effects

The magnitude of the effects of key variables is presented by Average Partial Effects (APE)[7] in tables 6 and 7. The APE statistics can be interpreted as the percentage increase/decrease in the likelihood of current labour force participation with respect to the change of a specific explanatory variable from 0 to 1. The results emphasize the degree of heterogeneity within severity categories. Severe work disability is significantly associated with the worst labour force performance regardless of which disability measure is used. Similarly, individuals with moderate disabilities (or work limitations) are less likely to participate in the labour force compared to individuals with mild or no disabilities. The participation gaps between the severity levels are increasing in severity and the widening gap is more pronounced for women. An interesting observation from Table 6 is the change in the effect of current disabilities when dynamics in labour force behaviour is considered. The APEs of moderate and mild work limitations drop, in absolute value, when past participation is controlled for. This implies that part of the low participation rates of these groups is attributable to their labour force participation status in the previous year. However, the adverse effect of severe work limitation becomes larger when the lag participation is included in the dynamic model. This change is larger in magnitude for men. This suggests that the way individuals are affected by severe disabilities are considerably different from the way they are affected by moderate or mild limitations. Unlike mild and moderate work limitations, the largest impact of severe work limitations are felt immediately after individuals become disabled.

The use of global disability reveals a similar picture of how the degree of severity is associated with labour force outcomes. For both men and women the likelihood of participation is significantly decreasing in severity. The APE of the severe disabilities on women's participation is striking. According to the Table 7, a severely disabled woman is approximately 60 percent less likely be a labour force participant compared to a non-disabled woman. This is substantially higher than what is observed for men (around 25 percent). The effect of disability is considerably lower for men when lag participation is included. This reduction is also observed for women but it is less in magnitude.

[7] See Wooldridge (2002) for a detailed discussion on Average Partial Effects.

Table 6: Average Partial Effects of the Key Variables, Work Limitation (%)

	Men		*Women*	
	Static Model	*Dynamic Model*	*Static Model*	*Dynamic Model*
$Severe_t$	-35.72	-41.81	-40.14	-42.89
$Moderate_t$	-13.93	-10.4	-9.77	-7.11
$Mild_t$	-3.06	-2.15		
$Severe_{t-1}$	-16.98		-36.82	-22.4
$Moderate_{t-1}$	-8.25		-9.4	-4.59
$Mild_{t-1}$	-0.65			

Note: APEs are computed only for the significant work limitation variables. The statistics are evaluated at the individual means of the explanatory variables. The effects are scaled by the estimated standard deviation of the random effects. Random effects are set to zero.

A comparison of Tables 6 and 7 reveals that the magnitude of the disability effect is sensitive to the choice of disability measure. Except for severe work limitations for men, the adverse effects of global disability categories are larger than those estimated using work limitation categories. This finding contradicts the justification bias hypothesis where the self-reported disability is expected to exaggerate the role of health on labour force participation. However, Stern (1989) reports similar results suggesting that self-reported disability may actually underestimate the health effect on labour force. It should be noted that this paper does not treat justification bias explicitly as in Stern (1989) and Cai (2007) and a comparison of the quantitative results between global disability and work limitations should be done with caution.

Table 7: Average Partial Effects of the Key Variables, Global Disability (%)

	Men		*Women*	
	Static Model	*Dynamic Model*	*Static Model*	*Dynamic Model*
$Severe_t$	-29.78	-25.91	-61.23	-59.68
$Moderate_t$	-20.24	-15.91	-17.85	-14.88
$Mild_t$	-6.05	-4.31	-4.39	-3.17
$Severe_{t-1}$	-11.15		-28.54	
$Moderate_{t-1}$	-10.04		-10.62	-4.65
$Mild_{t-1}$	-3.11		-3.48	-2.31

Note: APEs are computed only for the significant disability variables. The statistics are evaluated at the individual means of the explanatory variables. The effects are scaled by the estimated standard deviation of the random effects. Random effects are set to zero.

6. Controlling and Testing for Endogeneity of Work Limitation

In this section problem associated with endogeneity of reported severity levels is explicitly addressed. The estimation strategy is analogous to the cross sectional studies where more objective health information is used to instrument the subjective health status (Stern (1989), Cai and Kalb (2005), Bound et al (1995)).

Re-writing (1) as a function of latent severity level, S^*, yields following;

$$y_{it}^* = \gamma_1 y_{i,t-1} + \beta_1 X_{it} + \delta_{1j} S^*_{ijt} + \delta_{2j} S^*_{ij,t-1} + \alpha_i + \varepsilon_{it} \qquad (2)$$

True severity, S^*, is not observed, however is assumed to be a function of latent labour force status y_{it}^*, observed characteristics Z_{it}^* and unobserved heterogeneity η_i which is assumed to follow normal distribution with zero mean and variance sigma^2 nu.

$$S_{it}^* = \gamma_2 y^*_{it} + \beta_2 Z_{it} + \eta_i + \nu_{it} \qquad (3)$$

Observed severity S_{it}, on the other hand, is an imperfect proxy of the true status and depend on the true severity level and the labour force participation status of the individual.

$$S_{it} = S_{it}^* + \gamma_3 y^*_{it} + \tau_i + u_{it} \qquad (4)$$

The estimation of the model is carried in two steps. First, observed severity regressio is estimated using observed labour force status, specific health informatio (i.e. global severity measure) and observed characteristics of the individual. In the second stage, predicted values from the first stage estimatio is used in lieu of the true severity measure in (2)

--To be completed--

6.1 Robustness Check

In this section, results from the fixed effect specification of (2) and (4) are presented. The estimation methodology follows the GMM approach introduced by Arellano and Bond (1991). The advantage of this approach over random effects approach of the earlier sections is that researcher can be agnostic to the distribution of the unobserved heterogeneity as well as to the correlation between the unobserved heterogeneity and the observed characteristics. Another advantage of the fixed effects models is that it allows time invariant unobservable factors affecting labour force participation and severity reporting to be freely correlated across equations (2) and (4).

--To be completed--

7. Simulations

In this section, I simulate the effect of different severity levels on current and future effect dynamic labour force participation model introduced in section (3). The impact of severity is simulated for an average man and for an average woman separately. Figures 1 2 and 3 represent intertemporal labour force participation response of men and women that receive a work limitation shock at time $t = 1$. The response is simulated for 10 years following the limitation shock. In Figure 1 response to a mild limitation shock is presented. Figure 2 on the other hand replicate the same experiment for an individual who was hit by a moderate limitation shock. The response to severe limitation shock is presented in Figure 3.

--To be completed--

8. Conclusion

In this study the effect of the self-reported work limitations on labour force participation was investigated by allowing heterogeneity in severity levels. The results from the static and the dynamic panel data models indicated that the likelihood of labour force participation was significantly decreasing in severity of work limitations. This is consistent with the earlier findings based on functional limitations (i.e. Hum and Simpson (1998), Wilkins (2004), Gannon (2004)). The dynamic model showed that the effect of past participation was strongly significant indicating that current participation in labour force significantly increases participation in the future. Furthermore, controlling for past participation status reduced the impact of past work limitation on current labour force outcomes for men. In the absence of such a control, a static model predicts longer lasting effects for past severe and past moderate work limitations over and above the effect of current work limitations

The findings for women were considerably different. The effect of past work limitations was shown to be significant for women even after controlling for past labour force status. This may suggest that women are more severely affected by work limitations than men. Alternatively, unobserved individual-specific factors may jointly alter disability reporting and labour force participation, and can inflate the effect of past limitations for women. Results supporting the latter explanation are reported by Oguzoglu (2007).

The magnitude of the average partial effects was strikingly dissimilar across severity levels. The participation gap between two severity groups was shown to be increasing in severity. More importantly, although inclusion of past participation decreased the impact of mild and moderate work limitations, this was not the case for severe limitations. Estimates from the dynamic panel data model were larger for the severely work limited individuals compared to static model estimates. This implies that the impact of severe work limitations is sudden and severe work limitations force individuals to immediately drop out of the labour force regardless of their past labour force experience.

Robustness of results to the choice of disability measure was investigated using 'global disability' categories based on the SF-36 physical component summary scores. Qualitatively similar results were obtained. This finding is consistent with Burkhauser *et al* (2002) where employment trends of disabled individuals are shown to be very similar using different definition of disability. There were, however, quantitative differences. The effect of current disability was generally overestimated by global disability. The only exception was the severe work limitation for men where its effect was larger than that of the severe global disability. However, any quantitative comparison of the two alternative measures should be done cautiously due to the differences in the construction of the two measures. For example, although they were based on medical studies, the thresholds used to create global disability categories were somewhat arbitrary.

The findings in this paper emphasise the importance of treating disabled people as a heterogenous group. Estimated discrepancies in significance and magnitude across severity levels were remarkable. Policies that are designed to help disabled individuals participate in the labour market should therefore recognize this heterogeneity.

--To be revised--

Appendix A. Transition across Global Disability over Time

Table A1: Transition across Severity of Global Disability over Time (%)

MEN				
Status at t / *Status at t-1*	Not Disabled	Mild	Moderate	Severe
Not Disabled	87.71	11.29	0.99	0.01*
Mild	46.88	41.51	11.07	0.54*
Moderate	9.72	28.45	55.83	6.01
Severe	1.61*	3.23*	75.81	19.35*
WOMEN				
Status at t / *Status at t-1*	Not Disabled	Mild	Moderate	Severe
Not Disabled	87.45	11.4	1.13	0.01*
Mild	44.46	45.44	10.05	0.06*
Moderate	9.64	32.14	53.75	4.46
Severe	0*	9.09*	40.91*	50
ALL PERSONS				
Status at t / *Status at t-1*	Not Disabled	Mild	Moderate	Severe
Not Disabled	87.58	11.35	1.06	0.01*
Mild	45.57	43.63	10.52	0.28
Moderate	9.68	30.28	54.8	5.24
Severe	0.94*	5.66*	61.32	32.08

Note: The figures above are obtained using a balanced sample of waves 1 to 5 of HILDA.
* indicates less than 20 observations

Appendix B. Reported Working Hours by Work Limitation Status

Table A2: Working Hours by Employment and Work Limitation Status

	Work Limitation Status			
Labour Force/Employment status	Not Disabled	Mild	Moderate	Severe
Not in Labour Force	-	-	-	-
(%)	(14.64)	(16.00)	(46.91)	(91.75)
Unemployed	-	-	-	-
(%)	(2.24)	(2.40)	(4.36)	(0.97)
Employee	40	40	38	38
(%)	(67.29)	(66.58)	(35.60)	(5.34)
Employee of own business	46	50	48	70
(%)	(5.49)	(5.42)	(3.11)	(0.49)
Employer/own account worker	40	41	35	3
(%)	(9.99)	(8.74)	(9.39)	(1.46)
Unpaid family worker	15	28.5	41	-
(%)	(0.34)	(0.86)	(0.63)	(0.00)

Note: The figures above are obtained using a balanced sample of waves 1 to 5 of HILDA. The sample includes both men and women. The numbers in parenthesis indicate the percentage share in a given work limitation category.

References

Arellano, M. and S. Bond. (1991). "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." The Review of Economic Studies, 58, pp. 277-97.

Bound, J. (1991). "Self-reported versus objective measures of health in retirement models", *Journal of Human Resources*, 26 (1): 106-138.

Bound, J., Schoenbaum, M. and Waidmann, T. (1995). "Race and Education Differences in Disability Status and Labor Force Attachment", *Journal of Human Resources,* 30 (Supplement): S227- S267.

Bound, J. and Burkhauser, R.V. (1999). "Economic Analysis of Transfer Programs Targeted on People with Disabilities", in *Handbook of Labor Economics*. Vol 3 Ashenfelter and D. Card (eds.), New York: Elsevier Science.

Burkhauser, R.V., Daly, M.C., Houtenville A.J. and Nargis N. (2002). "Self- Reported Work-Limitation Data: What They Can and Cannot Tell Us", *Demography*, 39 (3): 540-555

Cai, L. (2007). "Is Self-Reported Disability Status Endogenous to Labour Force Status?", *Applied Economics Letters,* (forthcoming)

Dwyer, D. and Mitchell, O. (1999). "Health Problems as Determinants of Retirement: Are Self- Rated Measures Endogenous?", *Journal of Health Economics*, 18 (2): 173-193.

Gannon, B. (2004). "A dynamic Analysis of Disability and Labour Force Participation in Ireland 1995-2000", *Health Economics*, 14: 925–938

Heckman, J. (1981), "The Incidental Parameters Problem and the Problem of Initial Conditions in Estimating a Discrete Time-Discrete Data Stochastic Process", in *Structural Analysis of Discreet Data with Econometric Applications*. C.F. Manski and D.L. McFadden (eds.), London: MIT Press.

Jones, M. (2006). "Is There Employment Discrimination Against the Disabled?", *Economics Letters,* 92 (1): 32-37

Kapteyn, A., Smith, J.P. and van Soest, A. (2006), "Dynamics of Work Disability and Pain", *IZA Discussion Paper Series* No. 2057

Kerkhofs, M. and Lindeboom, M. (1995). "Subjective Health Measures and State Department Reporting Errors", *Health Economics*, 4: 221-235

Kreider, B. (1999). "Latent Work Disability and Reporting Bias", *Journal of Human Resources,* 34, (4): 734-769

Kreider, B. and Pepper, J.V. (2007). "Disability and Employment: Reevaluating the Evidence in Light of Reporting Errors", *Journal of American Statistical Association,* 102 (478): 432-441.

Jones, M.K. and Latreille, P. (2007). "Disability, Health, Caring and Labour Market Evidence from the Welsh Health Survey", *WELMERC Discussion Paper Series* No. 2007-01

Mundlak, Y. (1978). "On the Pooling of Time Series and Cross Section Data", *Econometrica*, 46 (1): 69–85.

O'Donnell, O. (1998). "The Effect of Disability on Employment Allowing for Work Incapacity", *University of Kent at Canterbury Department of Economics Working Paper Series* No. 98-13.

Oguzoglu, U. (2007). "Dynamics of Work-limitation and Work in Australia", *IZA Discussion Paper Series* No. 2867

Sanderson, K. and Andrews, G. (2002). "Prevalence and Severity of Mental Health Related Disability and Relationship to Diagnosis", *Psychiatric Services*, 53 (1): 80-86

Shields, M., Wheatley Price, S. and Wooden, M. (2007). "Life Satisfaction and the Economic and Social Characteristics of Neighbourhoods", *Journal of Population Economics*, (forthcoming)

Stern, S. (1989). "Measuring the Effect of Disability on Labour Force Participation", *Journal of Human Resources,* 24 (3):361-395.

Ware, J.E., Snow, K.K., Kosinski, M. (2000), *SF-36 Health Survey: Manual and Interpretation Guide*, Lincoln, RI, Quality Metric Incorporated.

Watson, N. and Wooden, M. (2004). "The HILDA Survey Four Years On", *Australian Economic Review*, 37: 343-349.

Hum, D. and Simpson, W. (1998). "Canadians with Disabilities and the Labour Market", *Canadian Public Policy*, 12 (3): 286-299

Wilkins, R. (2004). "The Effects of Disability on Labour Force Status in Australia", *Australian Economic Review,* 37 (4): 359-382.

Wooldridge, J. (2005). "Simple Solutions to the Initial Conditions Problem in Dynamic, Nonlinear Panel Data Models with Unobserved Heterogeneity", *Journal of Applied Econometrics,* 20: 39-54.