ESTIMATING THE EXTRA COST OF LIVING FOR PEOPLE WITH DISABILITIES

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Abstract

Addressing the extra economic costs of disability is a logical step towards alleviating elements of social exclusion for people with disabilities. This paper estimates the long run economic cost of disability in Ireland in terms of the additional spending needs that arise due to disability. It defines and estimates models of the private costs borne by families with individuals who have a disability in Ireland when compared to the wider population, both in general and by severity of disability. Our modelling framework is based on the standard of living approach to estimating the cost of disability. We extend on previous research by applying panel ordered probit models to Living in Ireland survey data 1995-2001 in order to control for the effects of previous disability and income and correlated unobserved heterogeneity. The approach allows us to quantify, for the first time, the additional long run economic costs of living associated with disability. Our findings suggest that the extra economic cost of disability in Ireland is large and varies by severity of disability, with important implications for measures of poverty.

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1. INTRODUCTION

In the context of increased risk of lower income for households of people with disabilities, addressing the extra economic costs of disability is a logical step towards alleviating elements of their social exclusion. In many countries there are a range of public supports for people with disabilities. The level and nature of government assistance are ultimately determined by social and political choices, but the design of the relevant policies should benefit from evidence on how disability affects the standard of living of affected individuals and their families. In this paper we estimate models of the private costs borne by households with individuals who have a disability in Ireland when compared to the wider population and provide such evidence for Ireland. Our modelling framework is based on the standard of living (SoL) approach to estimating the cost of disability as developed in Berthoud *et al.* (1993) and Zaidi and Burchardt (2005). We extend the estimation strategy by using panel data, which allows us to control for dynamics of disability and income along with unobserved heterogeneity, using an econometric modelling approach similar to that followed in Gannon (2005) and Contoyannis *et al*. (2004). In doing so we provide, for the first time, estimates of the long run economic cost of disability.

Our paper contributes to the literature in a number of ways. Earlier applications of the standard of living approach focused on the use of cross sectional models (Berthoud *et al.*, 1993; Indecon, 2004; Zaidi and Burchardt, 2005; Saunders, 2006), implying that important issues relating to unobserved heterogeneity and dynamics of disability remained unaddressed until now. For example, past disability and income could have an immediate effect on current disability and income respectively and hence on current standards of living. The advantage of our panel model over the cross sectional model is that it allows us to control for (1) within-individual effects (i.e. time

averages), (2) lagged levels of disability and income, and (3) to compare levels of severity of disability to households that did not contain a person with a disability in the sample period.

By using panel models we control for these effects and disentangle the impacts of disability into short run ('current') and long run ('lagged') effects. The unobserved component is inferred from the within- individual effect of disability and income (see Contoyannis *et al*., 2004). Disability, income and standard of living are likely to be endogeneously related, either because of direct effects (income on standard of living and vice-versa) or because of unobservables (e.g. time preference or previous investments in human capital). Our modelling approach, which follows that of Biewen (2004) and Gannon (2005), addresses these issues to a large extent and allows us to estimate consistent parameters even in the presence of such endogeneity.

By accounting for lagged disability and income and unobserved heterogeneity, we find that the long run economic costs of disability are higher than the short run costs suggested by cross-sectional models. We also find, similar to previous studies (e.g. Zaidi and Burchardt, 2005), significant difference between the short run economic cost of disability for those with severe and some limitations in their day to day activities. Our innovative results show that in the long run there is no significant difference in costs between those with severe or some limitations. Furthermore**,** the use of panel data models also allows us to estimate the economic cost of disability using a reference group of households that do not contain an individual with a disability throughout the panel, another important contribution of our research. These results suggest a similar pattern across severities, with no difference in the long run but significant differences in the short run.

2. STANDARD OF LIVING APPROACH

Previous research has drawn on a variety of approaches to quantifying the economic costs of disability. These include direct survey approaches (Martin and White, 1985; NRB, 1995; DIG, 1998) expenditure diary approaches (Matthews and Truscott, 1990; Jones and O'Donnell, 1995), budget standards approaches (Smith *et al*., 2004; Dobson and Middleton, 1998), as well as indirect approaches such as the standard of living approach. Indecon (2004), Tibble (2005) and Zaidi and Burchardt (2005) all provide good summaries of the merits of these different methods, though the sole focus here is on the standard of living approach.

The definition of additional costs implied by the SoL approach is the sum required to bring the standard of living of a household containing a person with a disability up to the same level as a comparable household where no members have a disability, controlling for relevant socio-demographic characteristics. This is a form of 'equivalisation', a technique which is routinely used when measuring poverty and inequality to adjust incomes for household size and composition. In this case however the adjustment takes account of disability-related needs. The concept of additional cost represents an approximation of the cost for any given group considered (e.g. by severity of disability) and involves averaging across individuals within a group. The resulting cost estimates include direct costs and additional costs of living associated with disability, but omit opportunity costs such as potential foregone earnings of disabled persons and their carers.

The SoL approach starts from the premise that, for a given income, disability status will reduce the living standards of households containing an individual with a

disability by causing them to divert a portion of their resources (income in our model) to cover disability-related costs. This diversion of resources can be quantified, taking account of other factors that affect measured standard of living. The standard of living approach has advantages over direct attempts to measure the cost of disability. It does not require estimates to be made of the sources or levels of specific costs associated with disability, which may require expert knowledge and the exercise of judgement on the part of respondents. Moreover, it is suited to estimation using large-scale micro datasets collected for wider purposes, so it is unlikely to be vulnerable to strategic response behaviour among those surveyed.

The method is essentially a "top-down" approach that aims to provide estimates of the economic cost of disability at a household level. While it does not specifically identify the items that contribute to these additional costs, depending upon available data it can account for variations in the level of costs across disabilities and conditions, as well as by severity. It does however ignore foregone earnings and other potential opportunity costs of ill health or disability.

The SoL approach to estimating the cost of disability is closely related to methods employed in assessments of material (or 'life-style') deprivation. Following Townsend (1979), considerable empirical research has been undertaken to identify 'deprived' individuals or households that are excluded from a specified minimum way of life or standard of living because of their lack of resources – for a survey see Perry (2002). Recent contributions to this literature treat deprivation as a latent variable and estimate it using methods that integrate traditional income-based measures with newer outcome-based indicators of social and economic exclusion - see for example Whelan *et al.* (2006). Outcome-based indicators have been particularly influential in Ireland,

forming the basis of the 'consistent poverty' measure used in the National Anti-Poverty Strategy.

The outcome-based indicators used in these analyses of deprivation are very similar to the standard of living indicators employed in the remainder of this paper. The main difference is that the deprivation indicators tend to focus on consumption items associated with a minimum adequate standard of living, whereas we wish to examine the effects of disability status over as wide a range of socio-economic outcomes as possible. Nevertheless, because these studies employ standard of living indicators, and we have earlier suggested that disability should reduce measured standard of living *ceteris paribus*, we should expect them to find a positive association between disability and deprivation.

The SoL approach is illustrated in Figure 1 using a simplified model based on Zaidi and Burchardt (2005). For a given level of income Y_0, a household containing a person with a disability is predicted to have a standard of living of S_0^D. The corresponding standard of living for a comparable household without a person with a disability is higher at S_0^{ND}. Graphically, the 'line' representing the relationship between standard of living and income for so-called 'disabled households' lies below and to the right of the line for 'non-disabled households'. The implication is that the disabled household could enjoy the same standard of living as the non-disabled household, but would require a higher income to do so. In Figure 1 for example, an income level of Y_1 gives the disabled household the same standard of living as the non-disabled household achieves at Y_0 i.e. $S_1^D = S_0^{ND}$.

[Insert Figure 1 here]

In the simple (deterministic) model represented in Figure 1, the standard of living of a household is expressed only as a function its income and disability status. (We subsequently introduce other control variables as well as a stochastic element in the econometric estimations). For the linear case in Figure 1, we can relate standard of living to income and disability status as:

$$S = \alpha + \beta Y + \delta D \qquad [1]$$

where Y represents disposable household income, D is an indicator variable defining the disability status of the household and α, β and δ are the equation parameters. Thus, in this simple case the additional cost of disability for a given standard of living is estimated as $\frac{dY}{dD} = -\frac{\delta}{\beta}$, or as $Y_1 - Y_0$ in the terms in Figure 1. The relationship between SoL and income may of course be non-linear and the most appropriate functional form can be tested for empirically.

3. DATA AND VARIABLES

The data are taken from the Living in Ireland (LII) surveys 1995-2001[i] and Table 1 sets out the variables of interest. The LII surveys represented the Irish component of the European Community Household Panel, now replaced by EU-SILC. The sample is representative of private households in Ireland and administered as a face-to-face interview. This longitudinal survey provides information on the social situation, financial circumstances and living standards of a panel of households. Within the sample there is considerable attrition over the period, with 3,575 households responding in 1995 and only 2,306 remaining in 1999[ii] – see Table 2. The sample

was thus boosted in the year 2000, with more than an additional 1,000 households. However, importantly for the analysis in this paper, Nolan *et al*. (2002) state that there is no evidence of serious attrition among those living in poor households or those towards the bottom of the income distribution. If anything, these households, along with individuals receiving social welfare payments associated with old age, disability or widowhood and older adults were less likely to be lost through attrition than other households.

[Insert Tables 1 and 2 here]

The dependent variable in the model is a proxy for each respondent household's unobservable standard of living and also summarised in Table 2. Following Berthoud *et al*. (1993) and Zaidi and Burchardt (2005), composite indicators of SoL comprising a set of individual indicators (e.g. does a household own a dishwasher) were considered. There are two desirable characteristics for the individual indicators that comprise the composite indicator and thus, by association, for the composite indicator. First of all, the individual indicators should be elastic with respect to income and, secondly, they should not be systematically related to disability status. Interested readers should consult Zaidi and Burchardt (2005) for a more complete discussion of the SoL variable.

The first desirable property is easily tested for empirically by undertaking, for example, a logit regression across households of each individual indicator on income and considering the estimated relationship. Indicators found to be significantly related to income (in an economic and statistical sense) are deemed suitable for inclusion in the composite indicator, provided they fulfil the second desirable

property. This second property is also worth considering however. According to Zaidi and Burchardt (2005), "variations in preferences or tastes are problematic only if they are systematically related to the characteristic of interest (in our case, disability); other variations will be 'averaged out'". Therefore, we would like to know that preferences for each of our individual indicators are not systematically related to disability status. Zaidi and Burchardt (2005) - nor the other studies that have utilised the SoL approach - do not test this second property empirically. Zaidi and Burchardt (2005) reference Ford (1997) and state that "composite indicators, based on a range of different items, may help, since even if there is a systematic relationship between need and preference on one item for a particular sub-group, the relationship is unlikely to be replicated across different items". Unfortunately, given our data, it is not possible to test for this impact empirically.

Based on tests of the first desirable property of the individual indicators[iii], and following previous studies, we use a composite SoL indicator derived as a function of household ownership of a number of 'goods' as well as whether the household took a holiday last year. The household goods considered are a microwave, a television, a car, a video, a freezer, a dishwasher and central heating. For each good a household in the LII survey is given a score of 1 if it owns the good (or if it took a holiday in the last year in the case of that variable). These scores are then totalled for each household. A composite indicator of SoL is then constructed by scaling the total score. It takes a value of 1 if a household scores a total of 0, 1 or 2 (11.3% of sample households), a value of 2 if it scores 3 or 4 (17.2% of sample households), a value of 3 if the household scores 5 (12.8% of sample households), a value of 4 if the household scores 6 (17.0% of sample households) , a value of 5 if the household scores 7 (19.6% of sample households) and a maximum value of 6 where a household scores 8

'positive' responses (22.2% of sample households). This scaling process was chosen in order to provide reasonably similar proportions in each of the composite indicator classes. We tested the robustness of the model estimates to changes in this method for creating the composite indicator and found it had little effect on the overall estimates and our key findings and conclusions. We also considered different subsets of indicators and again found little impact on the estimates of interest. It should be noted however that implicitly the approach gives equal weight to each item within the composite indicator and thus to the standard of living measure.

Once measured, standard of living is modelled as a function of a number of explanatory variables, with the main focus on the disability status of the household. The definition of disability status used in this paper thus warrants some discussion as there is an ongoing shift in focus about the definition of disability from the older *medical model* towards a *social model* (World Health Organisation, 1999) and an increased endeavour for greater integration of disabled people into society. The traditional medical form perceived individuals with disabilities as having an impairment that did not allow them to partake in mainstream social activities. The 1980 International Classification of Impairment, Disability and Handicap (ICIDH-1) proposed by the World Health Organisation (WHO) is a prime example of disability defined in medical terms. On the other hand, the social theory of disability stresses the discriminatory barriers in society. Disability is therefore an outcome of social attitudes and structures, and the interaction between the person and environmental factors. This was the approach adopted in 1999 by the WHO in the 1999 ICIDH-2 classification. In 2001, the 'International Classification of Functioning, Disability and Health' was approved by the WHO – this highlighted the interaction between the

individual and the environment. Interested readers are referred to Oliver (1996) for an in-depth discussion on the social model of disability.

This paper seeks to adopt the social model of disability using the available data. To start, an initial measure of disability is constructed from the LII survey on the basis of responses to the following question:

> "*Do you have any chronic physical or mental health problem, illness or disability*?"[iv]

However, it may well be that it is not only the presence of a disability that is important in determining costs, but also the extent to which it limits or restricts a person in their day-to-day lives. The LII surveys allows us to distinguish individuals in terms of those with either severe, some or no limitations in daily activities. Previous research (Gannon and Nolan, 2007) has exploited the differences in severity of limitations and found significant differences in terms of social inclusion. In the LII survey, respondents are asked:

> *"Are you hampered* [limited] *in your daily activities by this physical or mental health problem, illness or disability?*"

to which they could respond (1) yes, severely, (2) yes, some extent, or (3) no. This data allows us to directly estimate the cost of disability in Ireland by severity of disability for the first time and is more consistent with a social model of disability, as it allows us to interpret limitations in the context of environmental and social barriers. Table 2 sets out the number of households by disability status for each year in the dataset, while Table 3 summarises transitions in household disability status over the period considered.

[Insert Table 3 here]

Table 3 shows large outflows from being disabled to non-disabled at all levels of severity. This is consistent with other findings. Burchardt (2000) finds that just under 10 per cent have a one-off disability/limitation, hence there is an outflow from disability to no-disability.).

For the income variable we include the log of net disposable household income[v], which is calculated by aggregating income from all sources and deducting income tax and social insurance contributions. We also include a number of other explanatory variables in modelling household standard of living. These include variables relating to household size, the tenure status of the household, the location and region of the household, the number of children in the household as well as the age, gender and marital status of the head of household. These variables are described in more detail in Table 1.

4. MODEL, ESTIMATION AND RESULTS

4.1 Model

Our basic model for estimation is:

$$S_{it} = f\ (Y_{it}, D_{it}, \mathbf{X}_{it}^{H}, \mathbf{X}_{it}^{HoH}, \alpha_{i,} \varepsilon_{it}) \qquad [2]$$

where S_{it} denotes the standard of living of household *i* at time *t*, Y_{it} represents the disposable income of the household and D_{it} is an indicator variable defining the disability status of each household. We estimate a number of different models where D_{it} represents whether the household has a person with any disability, a severely limiting disability, a somewhat limiting disability and a non-limiting disability[vi]. $\mathbf{X}_{it}^{H}$

is a vector of household-level characteristics while $\mathbf{X}_{it}^{HoH}$ is a vector of characteristics relating to the head of the household. The error term is represented by ε_{it} and the model is estimated at the household level. In contrast to previous research (e.g. Zaidi and Burchardt, 2005), this paper uses panel data and hence can also incorporate unobserved heterogeneity into the model through the inclusion of α_i.

A number of issues arise in estimating the parameters of this model. Firstly, to separate out the impact of short run and long run costs, we introduce dynamics in the form of past disability and past income. We introduce lagged disability and income into the model to distinguish effects on SoL of those who have a longer term disability from those who have just acquired their disability. The implication of this is that we can then look at the effect of past (lagged) disability conditional on current standard of living, allowing us to look at the longer term effects of disability. This is important because people with a persistent disability may be less likely to recover and may have adjusted their lifestyle accordingly. This may of course depend on the severity of their disability, with those with a more severe disability having higher additional costs of living. For those without a disability previously, a new disability may require a lot more resources to keep standard of living the same as before.

Our model for estimation is an ordered response model including lagged disability and lagged income, and is based on an underlying latent variable S^* such that:

$$S_{it}^* = \alpha + \beta_1 Y_{it} + \beta_2 Y_{it-1} + \delta_1 D_{it} + \delta_2 D_{it-1} + \gamma_1 X_{it}^{H} + \gamma_2 X_{it}^{HoH} + \alpha_i + \varepsilon_{it} \qquad [3]$$

with

$$S_{it} = 1 \quad if \quad S^* \leq \tau_1$$
$$S_{it} = 2 \quad if \quad \tau_1 < S^* \leq \tau_2$$

$$S_{it} = J \quad if \quad S^* > \tau_J$$

and τ_j are the cut-points or thresholds in the distribution of S^* (Wooldridge, 2002).

For notational purposes, we let x_{it} now represent current and past disability and income, along with other variables, so equation [3] is now simplified to:

$$S_{it}^* = \alpha + \beta x_{it} + \alpha_i + \varepsilon_{it} \qquad [4]$$

In any panel model, an important issue concerns how to model the unobserved component α_i i.e. should we estimate a model with fixed effects or random effects? Our preferred option is the latter, since with the former, only very few observations contribute identifying information (Biewen, 2009). On the other hand, the disadvantage of random effects is that it assumes no correlation between explanatory variables and the unobserved effect. In our data, it is highly likely that there are individual unobservables influencing both explanatory variables (e.g. *D* and *Y*) and SoL. Therefore we estimate unobserved heterogeneity as correlated random effects, and our preferred modelling approach is an ordered probit[vii] model with correlated random effects.

In order to control for this, we follow the approach set out in Mundlak (1978) and Wooldridge (2002), whereby the distribution of the unobserved effect is conditional on the time averages of any potentially endogenous variables i.e.

$$\alpha_i = \phi \bar{x} + a_i \qquad [4]$$

where $a_i \mid x_i \sim Normal(0, \sigma_a^2)$ and $\bar{x}$ represents the means of potentially endogenous variables.

It is likely that income is endogenous with respect to standard of living. But the panel model requires strict exogeneity whereby conditional on α_i, the explanatory variables (x_i) would not be correlated with the error term ε_{it} for each household:

$$P(SoL_{it} = 1 \mid x_i, \alpha_i) = P(SoL_{it} = 1 \mid x_{it}, \alpha_i) \quad [5]$$

Once α_i is conditioned on, only x_{it} appears in response probability at time t. This rules out lagged dependent variables and some explanatory variables whose future movements depend on current and past outcomes on SoL.

In the standard of living model, this assumption is questionable since there may be feedback from current SoL to future income. We tested for strict exogeneity of disability and income by including future values of disability and income into the pooled model, following Wooldridge (2002). If the current values are strictly exogenous, we should find future values to be insignificant. In most cases we found that future values of income were significant (results available from authors). Hence, we do not rely on the standard random effects probit model, but instead estimate a pooled correlated random effects models. While we acknowledge the presence of variables that are not strictly exogenous, we can still obtain consistent parameter estimates (Biewen 2004).

The pooled model with time averages only requires contemporaneous exogeneity i.e. it only restricts the relationship between the disturbance and explanatory variables in the same time period. The pooled model can consistently estimate parameters even in

the presence of explanatory variables that are not strictly exogenous and so allows us to estimate a model of SoL controlling for correlated heterogeneity, providing consistent but inefficient estimates (Biewen, 2004; Gannon, 2005). The following assumption allows us to estimate consistent parameters by using a pooled ordered probit of SoL_{it} on 1, x_{it}, and $\bar{x}_i$:[viii]

$$\alpha_i \mid x_i \sim Normal(\bar{x}_i\phi, \sigma_a^2) \qquad [6]$$

In our complete model, the lagged values can then be interpreted as 'long term' effects, while the current levels of disability and income can be interpreted as 'current effects (see Gannon, 2005). In terms of disability and income, this increases the precision of our estimates significantly. Onset of disability might or might not have an immediate impact on standard of living, controlling for income. It is possible that a household with a person that acquires a disability will in the first instance not suffer a huge reduction in their income and standard of living. On the other hand, there could be some large one-off costs (adaptations to the home, purchase of equipment) meaning that purchases of other household goods which make up the standard of living index have to be deferred or foregone. In addition, onset of disability could cause a dramatic and immediate change in income, in the form of lost earnings. In the longer term, a household with a person with a longer-term disability could have a higher probability of a reduced standard of living. The increased recurrent costs of living (e.g. higher fuel, transport, and laundry bills) could take some time to feed through into an appreciable deterioration in the SoL index. Or alternatively, people may have adapted their lifestyle and those households now face less extra costs**.** Our findings, discussed later on, relate to these hypotheses and provide, for the first time, long-run estimates of the cost of disability.

The panel data available to us allows us to estimate models using households that did not contain a disabled individual in the sample period as a control group, which allows us to disentangle the true economic cost of disability. For example, households containing a person with a severe disability can now be compared to households who did not have a person with any type of disability in the sample timeframe, whereas previous cross sectional models could only make the comparison with households that did not have a disability in the same time period. It is possible that when we compare households with persons with a disability to households that may have had a person with a disability in the past, we are not estimating the full long term cost of disability. But when we compare households with persons to a disability to households who never had a disability, we estimate the 'full' long term extra cost of disability, in terms of standard of living.

4.2 Estimation

In previous papers different severities of disability were controlled for in a single model. For example, Zaidi and Burchardt (2005) estimated a cross sectional model with a continuous disability severity index. This allowed them to estimate the level of severity compared to lower levels of severity. In an earlier working paper (Cullinan *et al.*, 2008), we also estimated pooled models that compared different levels of severity to lower levels of severity. By exploiting the panel data more precisely, we can now also estimate separate models of SoL using each level of severity as a dummy variable and utilising a control group of households with no disabled members throughout the panel. This provides a more accurate estimate of the true cost of disability. Most likely, previous research has underestimated the true level of disability, since severity of disability was only compared to other levels of disability. It is more precise to estimate severity and compare the cost to households with no disability at all.

In summary, we estimate three types of models[ix]:

1. Pooled models for any disability[x] with (I) a single current disability variable; (II) current and lagged disability and income variables; (III) current, lagged and time average variables for disability and income.
2. Models including three levels of severity[xi] with (IV) a variable for each current level of severity i.e. severe, some and no limitations; (V) current and lagged severity and income variables; (VI) current, lagged and time average variables for severity and income.
3. Separate models for each level of severity (Models VII to XII), where the control group is households with no disabled members in the sample timeframe. These models include lags and time averages of disability severity and income.

4.3 Results

Tables 4 and 5 present the parameter estimates of the different econometric models described above, which can be used to estimate the economic cost of disability as a percentage of income ($C\hat{O}D$) by dividing the estimated coefficient on the relevant disability variable by the estimated coefficient on log income i.e. $C\hat{O}D = -\frac{\hat{\delta}}{\hat{\beta}_{LnY}}$.

These estimates for all of the econometric models are set out in Table 6 and Table 7.

[Insert Tables 4 and 5 here]

Model I, a basic pooled model including a general disability status variable, is our starting point. The coefficient on the disability status variable is estimated at -0.186

and found to be statistically significantly different from zero at the 1% level, implying lower standards of living for households containing a disabled person. This is as predicted by the standard of living approach. The estimated coefficient on log income is 0.815 and also significantly different from zero at the 1% level. Using the parameter estimates from Model I, the cost of disability as a percentage of income is estimated as 22.8%, with a 95% confidence interval of 14.9% to 32.2% of average household income. At the average (mean) weekly income for disabled households over the 1995 to 2001 period of €464.24, the implied cost of disability is €105.85 per week on average.

[Insert Table 6 and Table 7 here]

Model II includes current and lagged values of the general disability status and income variables. In this model the estimated parameters on the 'current' levels of disability and income variables are interpreted as short run or 'transitory' effects, while the estimated parameters on the lagged variables are interpreted as 'longer term' effects. This allows both short run and long run economic cost of disability estimates to be derived from Model II. Both the estimated short run and long run effects are negative and statistically significant. The implied long run cost of disability from this model is 24.1% (using the estimated parameters on the lagged variables) and is slightly greater than the short run estimate of 22.8% found using Model I or 21.9% using Model II. The results from Model II indicate that both 'current' and 'longer term' disability are costly.

Model III controls for correlation between potentially endogenous variables and unobservables and now finds that these current and long term impacts are no longer

significant. This is due mainly to the presence of unobservables in our model, the extent of which is captured by the coefficient on the averages in Model III. This implies that in Model III, the cost of disability is still large but mostly unobservable. This could be further disaggregated into the impacts of previous SoL (i.e. state dependence) and an unobserved component. We estimated dynamic models to assess this impact and found that the coefficients on the averages were subsequently lower. This confirms our hypothesis that much of the unobserved effect is due to previous SoL and disadvantage[xii]. Overall the results from Models I-III suggest that failing to account for dynamics of disability and unobserved heterogeneity may lead to underestimates of the long run economic cost of disability.

Model IV presents a pooled model accounting for differences in the impact of severity of disability on standard of living. As discussed, the LII surveys distinguish by severity of disability on the basis of the extent to which individuals are restricted in the daily activities. Three separate severity variables are included relating to the extent of limitation in day to day activities as a result of the disability. In this pooled model, the estimated impact of being disabled with a severe limitation is found to be greater than the impact of being disabled with some limitation. Both estimated coefficients are negative and statistically different from zero. This is in contrast to the estimated coefficient for the variable relating to being disabled with no limitation, which, though negative, is not statistically significantly different from zero.

The implied estimated economic costs of disability by severity of disability are found using Model IV by dividing the respective coefficients on each of the severity dummy variables by the coefficient on log income. Results are set out in Table 6. The cost of disability for households containing an individual with a severely limiting disability is

estimated at 30.4% of average household income, which translates to an average of €130.62 at the mean weekly income for these households. The cost of disability for households with a person who is somewhat limited by their disability is estimated at 18.4% of average household income, which translates to an average cost of €87.36 per week. The estimated cost of disability for households containing an individual who is not limited by their disability is not found to be statistically different from zero.

Model IV, while providing estimates by severity of disability, does not account for dynamics of disability and unobserved heterogeneity. To this end, Model V includes lags of each of the severity variables, as well as for income. Results indicate that for 'severe' limitations, the short run costs (30.0%) are higher than the long run costs (23.6%), though for 'some' limitations the long run costs (20.3%) are slightly higher than the short run costs (17.5%). It suggests that in the short run, people have to adjust to higher costs if they have severe limitations. Since several of the models depends on changes in disability status as part of their identification strategy it is important to highlight that there are large flows into and from disability status. Some of this change in disability status could partly explain why the estimates of long run costs are larger than the short run estimates, the former being less noisy.

In Model VI, when we control for correlated heterogeneity, we find that both the current and lagged disability effects are not statistically significant, as before. The coefficients on the averages are significant and when we modelled state dependence we found a significant reduction in the coefficients on the averages (results available from authors). Using the estimates in Table 5 for Model VI, the estimated cost of disability per week is €101.40 for households with a disabled member who is severely

limited and €96.38 for households with a disabled member who is somewhat limited, at the respective average weekly incomes for these households.

One drawback of Model VI is that the reference group to which disabled households are being compared is households that do not contain an individual with a disability in the current period. To address this, Models VII to XII present severity specific models in which households in the relevant category of disability are compared to a reference group of households which have not contained a person with a disability at any point during the time of the survey. Unfortunately, data is unavailable in relation to whether households contained a disabled member prior to the survey and thus we are unable to control for this. However, Models VII to XII represent an improvement on previous cross-sectional models, which compared disability to a reference group derived using disability status in the current period only. If disability in a previous period impacts on standard of living in the current period, such estimates may well be biased downwards. To better control for this, Models VII to XII compare the standard of living of households of different levels of severity to households that have not had a person with a disability during the course of the survey.

Table 5 presents parameter estimates from these three severity specific models, including models with current and lagged variables, as well as models with current, lagged and time average variables. Using the estimated coefficients on lagged variables, the long run economic costs of disability were estimated for each level of severity and are presented in Table 7. In general the estimated costs are greater than the corresponding estimates in Table 6, as would be expected given the differences in the reference groups. The estimated cost of disability for households with a disabled member who is severely limited in their daily activities is 37.3% in the short run.

This compares to 20.3% for households with a disabled member who is somewhat limited in their daily activities. In monetary terms, these translate to estimates of €160.26 and €96.38 per week on average respectively, suggesting a big difference between short run costs for households with disabled members that are severely and somewhat limited in their activities. In the long run, the models in Table 5 suggest that there is only a minimal difference between costs to households with severe or some limitation, but the former is insignificant. Hence, the results on long term costs for severity of disability in Table 7 are not conclusive. In comparison to these results, Zaidi and Burchardt (2005) find that severity of disability is an important factor and leads to higher costs. It is likely, in Table 5, that our data is not fully capturing the different severities of disability (e.g. compare a person who needs 24 hour care to a person who has a mild hearing impairment) and hence our results are different. It is possible that we do not obtain very different estimates for severe and some limitations in Table 5 simply due to the way that limitations are reported i.e. in terms of categorical data. But our results as a whole suggest that there is a relationship between severity of disability and cost, since all models find significant differences between non disabled (together with those who are disabled but not limited in daily activities), and those who are severely or somewhat limited.

5. CONCLUDING REMARKS

This paper applies the standard of living approach for estimating the cost of disability to Ireland. It extends on previous research by using panel data to control for previous disability and income, unobserved heterogeneity and endogeneity of income. Furthermore, using the panel data, we distinguish between short run and long run costs of disability. Our estimates are more precise since we also compare current

disability impacts to households who have not had a disabled member in the panel time period. This is likely to more accurately represent the true impact of each level of severity of disability. In summary, we find that the estimated long run cost of disability is similar for households with members that are severely and somewhat limited by their disabilities at 32.7% and 30.3% of average weekly income respectively, which translate to €140.50 and €143.86 per week on average. In contrast, in the short run, there is a large difference for households with members that are severely or somewhat limited. The rates are 37.3% and 20.3% of average weekly income respectively, translating to €160.26 and €96.38 per week on average.

Our findings are important for considering the effectiveness of policies that aim to address the economic problems associated with disability. They suggest that such policies do not go far enough in addressing the extra costs faced by the disabled community in Ireland. Furthermore, it is also worth reiterating that the estimated costs do not include any estimates or foregone earnings due to disability. The findings also have important implications for measurements of poverty in Ireland. The implication is that if disability reduces the standard of living of households for a given level of income, poverty measures based on income will underestimate the problem. In common with Zaidi and Burchardt (2005), we therefore suggest that the evidence presented here supports the case for the introduction of disability–adjusted poverty and inequality estimates and equivalence scales. While this is beyond the scope of this paper, we believe it represents an interesting and important avenue for future research.

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TABLES

Table 1: Variable Definitions and Summary Statistics for Selected Variables

Variable	Definition	Summary Statistics
Dependent Variable		*Mean (1995 - 2001)*
SoL	Standard of living indicator taking integer values from 1 to 6	3.83
Household Disability Status		*% of households in sample*
Disabled	= 1 if household contains an individual with a disability; = 0 otherwise	28.6%
Disabled with severe limitation	= 1 if household contains an individual with a disability who is severely limited in daily activities; = 0 otherwise	8.0%
Disabled with some limitation	= 1 if household contains an individual with a disability who is limited to some extent in daily activities; = 0 otherwise	22.6%
Disabled with no limitation	= 1 if household contains an individual with a disability who is not limited in daily activities; = 0 otherwise	9.5%
Other Explanatory Variables		*Mean (1995 - 2001)*
LnIncome	Natural log of disposable household income	€5.78
Household Size	Number of persons in household	3.38
Tenure	Tenure status of household	N/a
Region Dummies	Eight regional dummy variables	N/a
Location Dummies	Three location dummy variables	N/a
Number of Children	Number of children in household	0.97
Age of HoH	Age of head of household in years	54.1
Sex of HoH	= 1 if head of household is male; = 0 otherwise	N/a
Marital Status	= 1 if married or living with partner, = 0 otherwise	N/a

Table 2: Number of Households in LII Survey and Mean Estimated Standard of Living by Household Disability Status

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**1995 - 2001**
	Number of Households by Household Disability Status							
Disabled	996	856	848	775	654	982	814	5,925
Disabled with severe limitation	294	245	235	188	167	270	255	1,654
Disabled with some limitation	780	678	676	638	532	762	617	4,683
Disabled with no limitation	260	289	253	271	229	355	303	1,960
Not disabled	2,579	2,256	2,023	1,875	1,652	2,423	1,974	14,782
All households	3,575	3,112	2,871	2,650	2,306	3,405	2,788	20,707
	Mean Estimated Standard of Living by Household Disability Status							
Disabled	2.99	3.06	3.24	3.42	3.58	3.61	3.80	3.37
Disabled with severe limitation	2.64	2.73	3.08	3.16	3.39	3.42	3.59	3.12
Disabled with some limitation	3.08	3.15	3.28	3.50	3.64	3.70	3.87	3.44
Disabled with no limitation	3.29	3.54	3.87	3.84	3.88	4.21	4.34	3.88
Not disabled	3.54	3.69	3.87	4.03	4.20	4.39	4.52	4.02
All households	3.38	3.52	3.68	3.85	4.02	4.16	4.31	3.83

Table 3: Transitions in Household Disability Status

	Transitions (%)	
	All Types of Disability	
	No disability *t* (%)	Disability *t* (%)
No disability *t-1*	87.5	12.5
Disability *t-1*	29.3	20.7
	Severely Limiting Disability	
	Not severely limited *t* (%)	Severely limited *t* (%)
Not severely limited *t-1*	95.6	4.3
Severely limited *t-1*	48.5	51.5
	Limiting to Some Extent Disability	
	Not limited to some extent *t* (%)	Limited to some extent *t* (%)
Not limited to some extent *t*	87.1	12.9
Limited to some extent *t-1*	41.5	58.5
	Not Limited	
	No disability/limited *t* (%)	Not limited *t* (%)
No disability/limited extent *t*	92.8	7.2
Not limited *t-1*	60.7	39.3

Table 4: Parameter Estimates

	Pooled Models - Any Disability			Pooled Models - By Severity of Disability		
	Current	**Current and lags**	**Current, lags and time averages**	**Current**	**Current and lags**	**Current, lags and time average**
	[I]	**[II]**	**[III]**	**[IV]**	**[V[**	**[VI]**
Disabled	-0.186***	-0.114***	0.005			
	(0.029)	(0.026)	(0.025)			
Disabled with severe limitation				-0.247***	-0.155***	-0.034
				(0.043)	(0.039)	(0.039)
Disabled with some limitation				-0.149***	-0.091***	0.004
				(0.028)	(0.026)	(0.025)
Disabled with no limitation				-0.029	0.004	-0.033
				(0.036)	(0.034)	(0.029)
LnIncome	0.815***	0.519***	0.178***	0.814***	0.519***	0.180***
	(0.032)	(0.031)	(0.030)	(0.032)	(0.031)	(0.030)
Lagged Variables						
Disabled		-0.107***	0.015			
		(0.024)	(0.024)			
Disabled with severe limitation					-0.105***	0.017
					(0.039)	(0.036)
Disabled with some limitation					-0.090***	0.014
					(0.025)	(0.024)
Disabled with no limitation					-0.012	-0.033
					(0.034)	(0.029)
LnIncome		0.444***	0.089***		0.444***	0.091***
		(0.026)	(0.027)		(0.026)	(0.027)
Time Averages						
Disabled			-0.297***			
			(0.061)			
Disabled with severe limitation						-0.265***
						(0.103)
Disabled with some limitation						-0.263***
						(0.069)
Disabled with no limitation						0.142
						(0.106)
LnIncome			0.838***			0.834***
			(0.047)			(0.047)
Other Control Variables						
Household Size	Y	Y	Y	Y	Y	Y
Tenure	Y	Y	Y	Y	Y	Y
Region Dummies	Y	Y	Y	Y	Y	Y
Location Dummies	Y	Y	Y	Y	Y	Y
Number of Children	Y	Y	Y	Y	Y	Y
Age of HoH	Y	Y	Y	Y	Y	Y
Sex of HoH	N	N	Y	N	N	Y
Marital Status Dummies	Y	Y	Y	Y	Y	Y
Time Dummies	Y	Y	Y	Y	Y	Y
$\hat{\tau}_1$	2.624***	3.006***	3.740***	2.627***	3.013***	3.740***
	(0.197)	(0.234)	(0.251)	(0.197)	(0.234)	(0.250)
$\hat{\tau}_2$	3.619***	4.015***	4.766***	3.624***	4.022***	4.767***
	(0.198)	(0.236)	(0.254)	(0.198)	(0.236)	(0.253)
$\hat{\tau}_3$	4.147***	4.557***	5.318***	4.153***	4.566***	5.320***
	(0.199)	(0.237)	(0.255)	(0.199)	(0.237)	(0.254)
$\hat{\tau}_4$	4.781***	5.204***	5.976***	4.787***	5.213***	5.978***
	(0.201)	(0.239)	(0.257)	(0.201)	(0.238)	(0.256)
$\hat{\tau}_5$	5.548***	5.988***	6.772***	5.555***	5.997***	6.773***
	(0.203)	(0.241)	(0.259)	(0.203)	(0.240)	(0.258)
Pseudo R^2	0.187	0.195	0.202	0.187	0.195	0.203
Log pseudolikelihood	-25331.59	-20252.76	-20056.23	-25320.66	-20247.18	-20050.48
Observations	17,604	14,293	14,293	17,604	14,293	14,293

Note: Standard errors in parentheses. *** significant at 1%; ** significant at 5%; * significant at 10%.

Table 5: Parameter Estimates Using Severity Specific Models

	Disabled with Severe Limitation		**Disabled with Some Limitation**		**Disabled with No Limitation**	
	Current and Lags	**Current, lags and time averages**	**Current and Lags**	**Current, lags and time averages**	**Current and Lags**	**Current, lags and time averages**
	[VII]	**[VIII]**	**[IX]**	**[X]**	**[XI]**	**[XII]**
Disability Variable	-0.192*	0.020	-0.104**	0.039	0.032	-0.111
	(0.107)	(0.131)	(0.041)	(0.044)	(0.065)	(0.098)
LnIncome	0.515***	0.144***	0.512***	0.148***	0.473***	0.131**
	(0.044)	(0.050)	(0.039)	(0.042)	(0.046)	(0.055)
Lag of Disability Variable	-0.168	0.018	-0.144***	0.001	0.041	-0.022
	(0.120)	(0.126)	(0.042)	(0.044)	(0.067)	(0.097)
Lag of LnIncome	0.513***	0.142***	0.476***	0.101***	0.514***	0.143***
	(0.043)	(0.046)	(0.036)	(0.039)	(0.041)	(0.055)
Mean of Disability Variable		-0.434*		-0.386***		0.107
		(0.237)		(0.106)		(0.254)
Mean of LnIncome		0.880***		0.874***		1.717***
		(0.078)		(0.067)		(0.100)
Household Size	Y	Y	Y	Y	Y	N
Tenure	Y	Y	Y	Y	Y	Y
Region Dummies	Y	Y	Y	Y	Y	Y
Location Dummies	Y	Y	Y	N	N	N
Number of Children	Y	Y	Y	Y	Y	Y
Age of HoH	Y	Y	Y	Y	Y	Y
Sex of HoH	N	N	N	N	N	N
Marital Status Dummies	Y	Y	Y	Y	Y	Y
Time Dummies	Y	Y	Y	Y	Y	Y
$\hat{\tau}_1$	3.671***	4.417***	3.444***	4.145***	3.606***	9.601***
	(0.342)	(0.368)	(0.314)	(0.328)	(0.335)	(0.464)
$\hat{\tau}_2$	4.617***	5.383***	4.427***	5.147***	4.546***	11.486***
	(0.346)	(0.374)	(0.317)	(0.333)	(0.339)	(0.474)
$\hat{\tau}_3$	5.170***	5.945***	4.970***	5.700***	5.090***	12.568***
	(0.348)	(0.377)	(0.319)	(0.335)	(0.341)	(0.480)
$\hat{\tau}_4$	5.808***	6.591***	5.620***	6.360***	5.719***	13.770***
	(0.352)	(0.381)	(0.322)	(0.338)	(0.345)	(0.488)
$\hat{\tau}_5$	6.595***	7.389***	6.399***	7.150***	6.527***	15.316***
	(0.354)	(0.383)	(0.324)	(0.341)	(0.346)	(0.496)
Rho						0.735***
						(0.010)
Pseudo R^2	0.193	0.200	0.194	0.202	0.187	N/a
Log (pseudo)likelihood	-8000.28	-7927.04	-11024.94	-10918.27	-8913.42	-7303.80
Observations	5,816	5,816	7,885	7,885	6,482	6,482

Note: Standard errors in parentheses. *** significant at 1%; ** significant at 5%; * significant at 10%. 'Disability Variable', 'Lag of Disability Variable' and 'Mean of Disability Variable' relate to 'Disabled with Severe Limitation' in Models VII and VIII, 'Disabled with Some Limitation' in Models IX and X and 'Disabled with No Limitation' in Models XI and XII.

Table 6: Estimated Economic Cost of Disability – Models I, II, IV and V

	Pooled Model – Any Disability [i]	**Pooled Model with Lags – Any Disability** [ii]	**Pooled Model – By Severity of Disability** [i]	**Pooled Model with Lags – By Severity of Disability** [ii]
	[I]	**[II]**	**[IV]**	**[V]**
Estimated economic cost of disability as a % of income – Overall and by severity of disability				
			Short Run	**Long Run**
Disabled	22.8%	24.1%		
Disabled with severe limitation			30.4%	23.6%
Disabled with some limitation			18.4%	20.3%
Disabled with no limitation			3.5% [NS]	2.7% [NS]
95% confidence interval for estimated economic cost of disability as a % of income – Overall and by severity of disability				
Disabled	14.9% to 32.2%	11.9% to 39.5%		
Disabled with severe limitation			18.6% to 44.2%	5.6% to 46.4%
Disabled with some limitation			10.8% to 27.2%	8.3% to 35.3%
Disabled with no limitation			-4.8% to 13.3%	-11.3% to 11.9%
Estimated mean weekly income for disabled households (€) – Overall and by severity of disability				
Disabled	464.24	464.24		
Disabled with severe limitation			429.66	429.66
Disabled with some limitation			474.78	474.78
Disabled with no limitation			583.59	583.59
Estimate economic cost of disability per week at mean income level for disabled households (€) – Overall and by severity of disability				
Disabled	105.85	111.88		
Disabled with severe limitation			130.62	101.40
Disabled with some limitation			87.36	96.38
Disabled with no limitation			20.43 [NS]	15.76 [NS]

[i] Economic cost of disability estimated using coefficients on 'current' variables in Table 4.

[ii] Economic cost of disability estimated using coefficients on 'lagged' variables in Table 4.

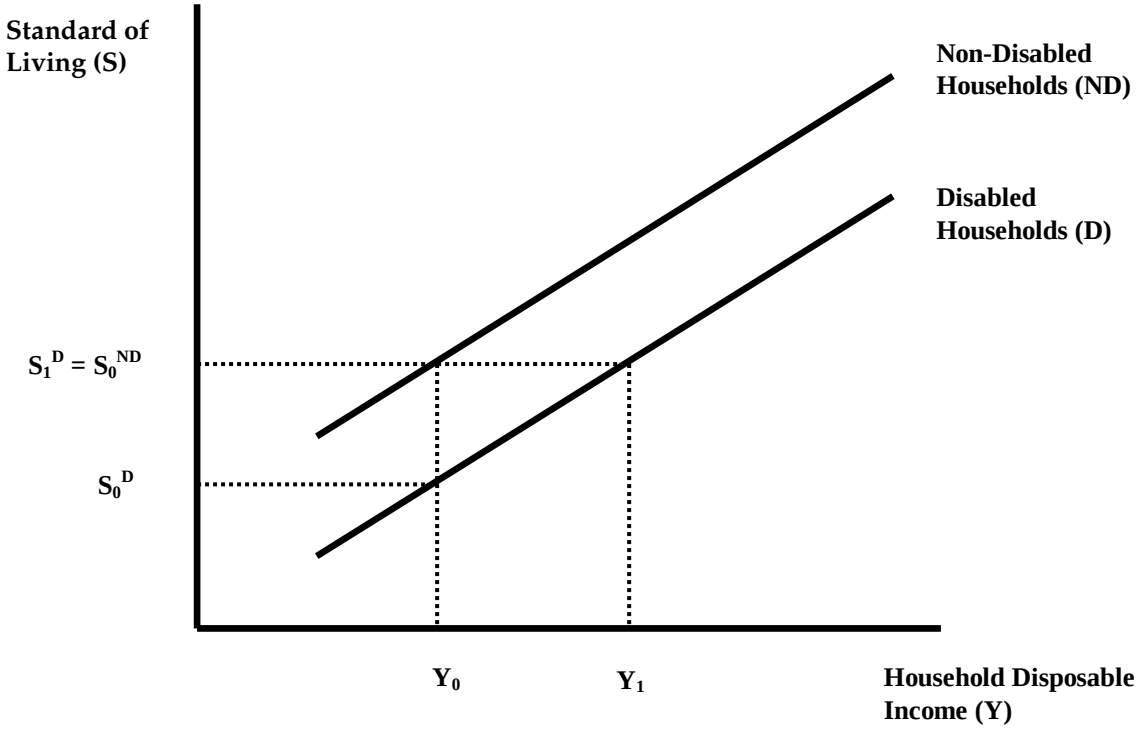
Table 7: Estimated Economic Cost of Disability – Models VIII and IX

	Disabled with Severe Limitation		Disabled with Some Limitation	
	Current and Lags [VII] [ii]		Current and Lags [IX] [ii]	
Estimated economic cost of disability as a % of income – By severity of disability	**Short Run**	**Long Run**	**Short Run**	**Long Run**
Disabled with severe limitation	37.3%	32.7% [NS]		
Disabled with some limitation			20.3%	30.3%
95% confidence interval for estimated economic cost of disability as a % of income – By severity of disability				
Disabled with severe limitation	-2.9% to 94.0%	-11.3% to 94.3%		
Disabled with some limitation			3.8% to 42.4%	11.3% to 55.8%
Estimated mean weekly income for disabled households (€) – By severity of disability				
Disabled with severe limitation	429.66	429.66		
Disabled with some limitation			474.78	474.78
Estimate economic cost of disability per week at mean income level for disabled households (€) – By severity of disability				
Disabled with severe limitation	160.26	140.50 [NS]		
Disabled with some limitation			96.38	143.86

[ii] Economic cost of disability estimated using coefficients on 'lagged' variables in Table 5.

FIGURES

Figure 1: The Standard of Living Approach



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i The question posed about illness or disability in the initial 1994 LII survey is different to the one used in subsequent years and therefore we do not use data for 1994 in our estimations.

ii Non random attrition and its impact were tested for in Gannon (2005) and found not to bias estimates of disability in a labour force participation model.

iii Details of these tests are available on request.

iv Interviewers are instructed to ask for a disability or a long term health condition that is expected to last at least six months – this avoids inclusion of short-term illness such as flu in the data.

v A log income specification was chosen following the analysis presented in Cullinan *et al*. (2008).

vi We discuss the various models and specifications later in this section.

vii Zaidi and Burchardt (2005) estimate logit models but we use probit models to facilitate inclusion of unobserved effects.

viii In order to estimate a full conditional MLE we would require that $y_{i1},...,y_{iT}$ are independent conditional on (x_i, α_i) (Wooldridge, 2002, pp.508.)

ix We also estimated dynamic linear models with fixed effects and these models gave similar results. These are available on request.

x This is coded as a (1,0) variable where 1 denotes that a household contains an individual with a disability, regardless of the level of severity.

xi Three separate disability-related variables are computed for severe (1,0), some (1,0) or no (1,0) limitations and these are included into the regression, with households containing no disabled member representing the reference group.

xii Results for these dynamic models are available from the authors.