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Equivalence scales and the costs of disability

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Abstract

The impact of disability on household welfare is estimated by equivalence scales using data from the 1986–87 FES Disability Survey. Three methods of identifying scales from cross-section data are considered; these imply a series of restrictions that are tested on quadratic logarithmic Engel curves. The results indicate that there are substantial consumption costs associated with physical disability.

Key words: Equivalence scales; Disability

JEL classification: D1; I12

1. Introduction

Disability undoubtedly affects an individual's quality of life; but it may also have a specific effect on the spending patterns of the disabled person's household. This fact is recognised in the social security systems of most developed countries through the provision of benefits to compensate for consumption costs associated with disability. This paper attempts to measure the magnitude of such costs by constructing equivalence scales for disability. As far as we are aware, this is the first attempt to use equivalence scales to

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measure the impact of health on household living standards. As an empirical exercise this is made possible by the FES Disability Survey, a newly available dataset compiled by the OPCS from a follow-up interview of disabled adult respondents to the UK. Family Expenditure Survey between July 1986 and June 1987.

The only previous analysis of the FES Disability Survey data has been carried out at the UK Department of Social Security (DSS) (Matthews and Truscott, 1990), with the aim of measuring the extra costs of disability and comparing them to subjective assessments of these costs obtained from the OPCS Disability Surveys (Martin and White, 1988). Both the DSS and OPCS research influenced the reforms of disability-related benefits introduced in April 1992.[1] The OPCS study found that among recipients of the relevant benefits, on average, the social security system more than compensated for the extra expenditures reported. The DSS research did not identify the costs of disability, partly because no rigorous definition of these costs was given.

Here such costs are defined as the extra expenditure required by a household with a disabled person to achieve the same level of welfare as a reference household without any disabled individuals. The relative (absolute) consumption costs of demographic characteristics are obtained by taking the ratio (difference) of cost functions for households with different characteristics, but facing the same set of prices. It is standard practice to include the number of individuals and their age (particularly for children) among the list of demographic characteristics; the problem considered here is why and how disability should be incorporated into this approach.

In Section 2 the conceptual framework provided by household production theory is used to argue that disability may increase the expenditure required to achieve a given level of welfare from market goods. The issue of identification is then considered. Whilst it is recognised that the full welfare effects of disability cannot be identified from demand data, it is argued that the fact that disability has a negative direct effect on welfare allows the costs obtained from identifiable equivalence scales to be considered as a lower bound for the full welfare costs of disability. A second identification problem arises from the cross-section nature of the data available, which has no price variation. The restrictions on preferences required to identify scales from such data are considered in Section 3, and these are translated into a series of parametric restrictions. Section 4 shows that tests of these restrictions on the estimated non-linear Engel curves suggest that (modified) Engel scales derived from some budget share equations cannot be rejected.

[1] Disability Living Allowance (DLA) replaced Mobility and Attendence Allowance and is designed to compensate for the extra cost of living associated with disability. In comparison with the earlier system, DLA has extended entitlement to the less severely disabled.

All the scales are positive, indicating that disability raises the cost of household consumption. The estimated scales for fuel and transport suggest that the relative costs of disability are large, but these estimates are poorly determined. Section 5 concludes with a discussion of the implications and limitations of this analysis.

2. The costs of disability: Definition and measurement

Conceptually, the impact of disability on the cost of achieving a given level of welfare can be viewed through the theory of household production. Certain fixed inputs are required only by people with disabilities; for example wheelchairs, bathroom hoists, and hearing aids. Other inputs are only required by the disabled but at a level that varies with the amount of basic commodities consumed; for example the carer's time, and books in braille. Some goods cannot be used by the disabled; for example dietary restrictions for diabetics, and buildings and transport with inadequate access for the physically disabled. By constraining the input set, such restrictions may imply higher costs of achieving a given level of welfare. Disability may also affect the productivity of goods that are consumed by both disabled and non-disabled people, either directly or through the time input required for consumption. These productivity effects will affect the fixed and variable costs of household production and should be reflected in the household's cost function.[2] One approach to measuring the costs of disability would be to estimate directly the impact on household technology. However, direct estimation of the structural parameters in a household production model is difficult in the absence of data on basic commodities (see, for example, Pollak and Wachter, 1975).[3] Our own approach aims to identify the impact of disability on spending patterns over market goods and use the estimates to construct equivalence scales.

Equivalence scales are defined in terms of cost functions, which must be estimated from observed demand data. These data only provide information on preferences conditional on demographic characteristics while, in general, it is unconditional preferences that are required to recover the impact of demographic characteristics on welfare (see, for example, Pollak and Wales, 1979; Fisher, 1987; Lewbel, 1989; Blundell and Lewbel, 1991). Despite this identification problem, observed demands may be used to identify the partial welfare effects of demographic characteristics. Deaton and Muel-

[2] Formal treatments of the relationship between the form of the cost function and household production technology are provided by Gorman (1976) and Lewbel (1985).

[3] Atkinson and Stern (1981) show how certain technology parameters may be estimated from market demand data by exploiting information on wage rates.

lbauer (1980, pp. 209–212) argue that the direction of bias in using conditional scales will depend on the sign of the marginal rate of substitution between the demographic characteristic and the direct utility from consumption. If it is accepted that the direct effect of disability is to reduce welfare, then equivalence scales derived from observed demands will give a lower bound for the costs of disability, in this case empirical evidence of excess costs would form the basis for welfare-improving policy interventions.

Identification of the full cost of disability would require evaluation of the direct welfare effect of disability, which moves into the realm of quality of life measurement (see, for example, Torrance, 1986). Whether one should aim to calculate the full costs of disability, or merely those which can be identified from demand data, depends upon the policy issue to be considered.[4] In legal matters there may be interest in the compensation necessary to restore a disabled individual to the same level of welfare they would experience if they had not been disabled. In matters of social security the costs of interest are likely to be more narrowly defined.

Analyses of the costs of children typically use adult welfare to make the comparison between households with and without children (see, for example, Deaton and Muellbauer, 1986). This approach is not appropriate in the case of disability, where it the presence of the disability, not the disabled individual, that is the basis for the welfare comparison.[5] If an equivalence scale can be identified it should therefore be interpreted as a measure of the consumption cost of the disability on all members of the household and not a measure of the effect of disabled individuals on the welfare of the non-disabled members of the household.

In general, an equivalence scale is defined by

$$c(u, p, z) = c^{r}(u, p)R(u, p, z) , \tag{1}$$

where $c^{r}(u, p) = c(u, p, z^{r})$ is the cost function for the reference household and $R(u, p, z)$ is the scale for demographic characteristics z, which depends on the base level of utility (u) and prices (p). In our application the dataset is a single cross-section, with no price variability; however, if there is some restriction on the price dependence of the scale, then identification can be achieved (Muellbauer, 1974). The most restrictive case makes the scale independent of all prices. This requires multiplicative separability between

[4] Deaton and Muellbauer (1980) make the distinction between welfare comparisons and policy comparisons.

[5] In practice this means that the estimating equations should include a variable for the number of adults in the household (including any disabled individuals) along with a variable for the number of disabled individuals. The reference household (for the purpose of welfare comparisons) is defined when the latter equals zero.

prices and demographics in the cost function (Blackorby and Donaldson, 1992). If this restriction holds, the budget share of any good will be an indicator of welfare.

Independence of the scale from all prices is sufficient but not necessary for identification. If the scale is independent of the price of any one good, the budget share of that good will be an indicator of welfare and the true scale is given by the Engel scale for that good (see, for example, Murthi, 1992; Dickens et al., 1993).

Rather than use the demand for a single good as an indicator of welfare, the Rothbarth and Iso-Prop[6] methods use the level and share of expenditure, respectively, on a group of goods. Usually this group is defined as 'adult goods', i.e. goods consumed by adults but not by children. Clearly it would be difficult to identify goods that are 'non-disability' goods in the same sense that adult goods are 'non-child' goods. However Deaton et al.'s (1989) concept of demographic separability offers a possible alternative. They define a group of goods as being demographically separable if the impact of demographics on demand is proportionate to the income effect for all goods in the group.[7]

The relevance of demographic separability for the construction of equivalence scales arises from the fact that it is a consequence of price independence and so provides a weak test of the restriction.[8] For the scale to be independent of the price of each good in a group, the cost function can be restricted to take the form

$$c(u, p, z) = C(u, p)D(u, p_2, z) , \tag{2}$$

where p_2 is the vector of prices for goods that are not in the separable group. The demographic separability restriction,

$$\partial w_i / \partial z = \theta^z \, \partial w_i / \partial y , \tag{3}$$

where $w_i = p_i x_i / y$, y is income, $\theta^z = (\partial \mathcal{U} / \partial z)/(\partial \mathcal{U} / \partial y)$, and $u = \mathcal{U}(p, y, z)$ is indirect utility, follows from the cost function. Thus demographic separability of a group of goods is necessary, but not sufficient, for a scale to be independent of all prices in the group, and for the budget share of any one

[6] Some authors use Iso-Prop synonymously with the Engel method. Here we maintain a distinction between scales calculated from individual goods and those calculated from groups of goods.

[7] Deaton et al. claim that demographic separability in levels of expenditure is necessary, though not sufficient, for the Rothbarth method to be valid. This argument is refuted by Blackroby and Donaldson (1992) who identify the restrictions on preferences that are necessary and sufficient for the Rothbarth and Iso-Prop procedures to yield true indicators of welfare.

[8] Dickens et al. (1993) use the terms demographic separability and price independence interchangeably. Here we stick with Deaton et al.'s original definition.

of those goods to be an indicator of welfare.[9] The definition of a demographically separable group of goods yields cross-equation tests for the independence of the scale from two or more prices. For example, for a pair of goods, say i and j, (3) gives the restriction[10]

$$\left[\frac{\partial w_i}{\partial z}\bigg/\frac{\partial w_i}{\partial y}\right]\bigg/\left[\frac{\partial w_j}{\partial z}\bigg/\frac{\partial w_j}{\partial y}\right]=\frac{\theta^z}{\theta^z}=1\,. \tag{4}$$

3. Estimation and testing

Evidence from recent studies based on the FES suggests that a quadratic extension of the Working–Leser functional form gives a good representation of the data (see, for example, Blundell et al., 1989; Banks et al., Lewbel, 1992). Our unrestricted estimating equation for the budget share of each good (w_i) is

$$w_i=\beta_{0i}+\beta_{1i}z+\beta_{2i}\ln(y)+\beta_{3i}z[\ln(y)]+\beta_{4i}\ln(y)^2+\beta_{5i}z[\ln(y)^2]+\varepsilon_i\,, \tag{5}$$

where ε_i is an i.i.d. random disturbance. Eq. (5) can be rationalised by a quadratic logarithmic cost function (see Banks et al., 1992)

$$\ln c(\cdot)=b(p,z)\left[\frac{1}{(\ln(u))^{-1}+\lambda(p,z)}\right]+a(p,z)\,, \tag{6}$$

where, by Shephard's lemma, the share equations corresponding to (6) are

$$w_i=a_i(p,z)-\frac{b_i(p,z)}{b(p,z)}a(p,z)-\frac{\lambda_i(p,z)}{b(p,z)}[a(p,z)]^2+\frac{b_i(p,z)}{b(p,z)}\ln(y)$$
$$+2\frac{\lambda_i(p,z)}{b(p,z)}a(p,z)\ln(y)-\frac{\lambda_i(p,z)}{b(p,z)}[\ln(y)]^2\,, \tag{7}$$

where $a_i(p,z)=\partial a(p,z)/\partial \ln p_i$, etc.[11]

[9] Given (2) the Iso-Prop method is valid, but Blackorby and Donaldson (1992) show that the method can be valid under a more general cost function.

[10] Unlike the within-equation tests of price independence given by Murthi (1992) and Dickens et al. (1993), this cross-equation restriction is not conditional on the independence of the base utility (IB) property.

[11] Interpreting (5) as being consistent with (7) means that the β's are price-dependent but can be treated as fixed in a single cross-section. For notational convenience this equation is written in terms of a single disability characteristic (z) and the other demographic variables are ignored. Terms involving z^2 have been incorporated into the z term as the z's are measured as binary variables in the empirical estimation.

Three methods of identifying scales from (5) are considered:

Method 1. If the scale is independent of the price of the *i*th good, the budget share of that good is an indicator of welfare. Equating the share of a given household with a disabled person to that of the reference household and solving for the difference in log-incomes identifies the log-scale.[12] This method does not require the assumption that the scale is independent of the base level of utility (the IB property).[13] We use the demographic separability restriction as an indicator of price independence.

Method 2. This is a special case of method 1 where the Engel restrictions of IB and price independence of good i are both imposed. Then, the log-scale associated with (5) is $-\beta_3/2\beta_4$. Deaton and Muellbauer (1986) and Murthi (1992) both use a restricted version of (5) to estimate scales from food share equations.

Method 3. The Engel, Rothbarth and Iso-Prop methods yield true scales under (different) restrictions on price dependence. Dickens et al. (1993) argue, in the context of share equations that contain non-linear and heterogeneous income effects, that it is possible to identify scales without any such restrictions. However, the result does require IB. When IB is imposed on (6), by making $b(\cdot)$ and $\lambda(\cdot)$ independent of z, and setting $z = 0$ for the reference household and assuming that $a(\cdot)$ is linearly homogeneous in z, the log-equivalence scale is $a(p, z)$ (see Dickens et al., 1993).[14] If a restricted version of (5) is consistent with an IB version of (7), then the log-scale is again identified by $-\beta_3/2\beta_4$.

Although methods 2 and 3 give the same expression for the scale, according to the latter any share equation can be used to identify the scale, whilst the (modified) Engel approach requires that the scale be independent of the price of the good in question. The basic assumptions involved can be expressed as a series of restrictions on the parameters of (5). These define a sequence of tests that can be applied to the estimated share equations.

If the scale is independent of the price of more than one good these goods form a demographically separable group and Eq. (4) can be used to give a cross-equation test for separability.

[12] A linear approximation is given by $-[\partial w/\partial z]/[\partial w/\partial \ln(y)]$.

[13] IB is unattractive from a normative viewpoint as it means that the monetary compensation implied by the equivalence scale will be inversely proportional to household income. Without IB a unique scale does not exist. In such circumstances, a range of scales varying with household incomes could be presented.

[14] The assumption of linear homogeneity imposes diseconomies of scale in the demographics on the equivalence scale, $\exp(a(p, z))$. Whilst this is undesirable in general, in our application the z's are binary indicators and so scale effects are not considered.

[R1] *Demographic separability*:

$$\frac{\beta_{1i} + \beta_{3i}\ln(y) + \beta_{5i}\ln(y)^2}{\beta_{2i} + \beta_{3i} + 2(\beta_{4i} + \beta_{5i})\ln(y)} \text{ equal for all goods in the group .}$$

Wald tests are calculated by imposing the restriction on pairs of goods.[15,16]

[R2] *Independence of base (IB)*: $\beta_{5i} = 0$ for all i .

Dickens et al. (1993) note that significant coefficients on the interaction terms between z and $\ln(y)^2$ are sufficient to reject the IB assumption. Of course non-rejection of [R2] does not necessarily imply acceptance of IB. Murthi (1992) shows that the restriction is necessary for the validity of the Engel method in the context of (5).

[R3] '*Quadratic Preferences*': $-\beta_{3i}/2\beta_{4i}$ equal for all i .

This cross-equation restriction is a test of data consistency with the preferences hypothesised in an IB version of (6).[17] The restriction is imposed in Dickens et al. (1993), where the commodity demands are estimated as a system. With IB preferences the restriction implies that the equivalence scale is the same irrespective of the share equation used to calculate it. Here we calculate Wald tests for pairs of goods. In principle, rejection for any pair of goods is sufficient to reject the assumption.

[R4] *Price Independence*: $\beta_{1i} - \beta_{3i}(\beta_{3i} + 2\beta_{2i})/4\beta_{4i} = 0$ for each i .

This restriction is suggested by Murthi (1992), who presents it as a within-equation test for the Engel method. If (5) is consistent with (7) the restriction is also valid as a test of price independence of individual goods, and can be derived by assuming IB and setting $a_i(p, z) = 0$.

[15] In the special case of the Working–Leser form ($\beta_3 = \beta_4 = \beta_5 = 0$) this is a parametric restriction and is not data-dependent. In this case it is also possible to calculate a LR statistic by imposing the restriction $\beta_{1i} = \theta\beta_{2i}$ on selected groups of equations.

[16] Most of these restrictions, both within and across equations are non-linear in the parameters and the tests are calculated as Wald statistics. A potential problem here is that Wald tests based on non-linear restrictions are not invariant to (mathematically equivalent) reformulations, for example the separability restrictions could be expressed as products rather than ratios (see, for example, Gregory and Veall, 1985). Our strategy is to calculate Wald tests for both ratios and products and note any discrepancies. In Table 2 we report statistics for the restrictions as presented in the text.

[17] For non-IB preferences the corresponding restriction is based on $-\beta_{3i}/2(\beta_{4i} + \beta_{5i})$, which clearly reduces to [R3] when $\beta_{5i} = 0$.

[R5] *Log-scales*: $-\beta_{3i}/2\beta_{4i} = 0$ for each i .

This restrictions indicates whether the log-scale, calculated on the basis of good i, is significantly different from zero. Dickens et al. (1993) label this condition demographic homotheticity.

[R6] *Linear Model*: $\beta_{4i} = 0$ for all i .
Linear IB: $\beta_{4i} = \beta_{3i} = 0$ for all i .

These restrict the quadratic Engle curves to the Working–Leser form and its IB variant (see eg. Blundell and Lewbel, 1991).

[R7] *Disability effect*: $\beta_{1i} = \beta_{3i} = \beta_{5i} = 0$ for each i .

This final restriction simply tests whether any of the disability variables are jointly significant.

4. Data and results

The data are taken from the 1986–87 FES Disability Survey. The survey involved screening the FES sample to identify individuals with some form of disability. Types of disability covered in the survey ranged across a wide spectrum, for example difficulties in locomotion, dexterity, intellectual functioning and personal care. Information on degrees of functioning is grouped to give five types of disability: physical, mental, hearing, sight, and other disabilities.[18]

Of the 7371 households in the survey, 1382 included at least one disabled individual. As an attempt to separate the effects of disability and ageing, the sample is restricted to households whose heads are non-retired and aged under 65. For comparability with the DSS analysis and OPCS Disability Survey the sample excludes households from Northern Ireland. To allow for extreme outliers, observations in the first and last percentiles of the distributions of net income and total expenditure on non-durables are also excluded. This resulted in a sample of 5060 households. The variables used

[18] Disability is defined in accordance with the International Classification of Impairments, Disabilities and Handicaps as things people cannot do as a result of impairment. The questionnaire is divided into 14 sections asking about degrees of functioning in different areas, such as walking, reaching and stretching, understanding others, etc. Multivariate factor analysis is used to identify 13 types of disability. The 13 types are then combined into five groups according to the origin of the impairment: physical (locomotion, reaching and stretching, personal care, disfigurement), mental (behaviour and intellectual functioning), hearing (hearing, communication), sight (seeing), other (incontinence, consciousness, digestion).

to estimate the Engel curves are described in Table A1 in the appendix. Share equations are estimated for a system of seven categories of non-durable expenditures: fuel, transport, services, food, alcohol, clothing, and other goods. The impact of disability is measured by dummy variables for one or more individuals with each type of disability.[19]

The budget shares are estimated equation by equation by a generalised method of moments estimator (GMM), which in this case means linear instrumental variables with White's heteroskedasticity correction (see, for example, Blundell et al., 1989). The IV estimation is intended to take account of measurement error in total expenditure due to infrequency of purchase. The instruments are the logarithm of household net income and appropriate quadratic and interaction terms to match the terms in $\ln(y)$, along with additional demographic variables included as overidentifying variables.[20]

Estimated Engel curves

The physically disabled comprise the largest group amongst the disabled population and discussion of consumption costs tends to concentrate on this type of disability (Berthoud, 1991).[21] For brevity only results relating to physical disability are presented. Table 1 presents coefficient estimates for the total expenditure and physical disability variables for share equations corresponding to (5).[22,23] Table 1 also gives Hausman tests for the exogeneity of terms involving total expenditure, and Sargan statistics for the validity of the instruments.

The marginal budget effects [$\partial w/\partial \ln(y)$, evaluated for the reference household at the mean of $\ln(y)$] indicate that fuel, food and alcohol are necessities. Only in the case of alcohol does the sign of the budget effect for a household with a disabled person differ from that of the reference household. The impact of physical disability (the mean of $\partial w/\partial z$ over disabled households) is positive of fuel, services and food. So, disability is associated with a greater budget share on necessities, while for luxuries disabled households spend proportionately less. If log-scales are calculated by $-(\partial w/\partial z)/(\partial w/\partial \ln(y))$ this implies a positive scale and hence positive

[19] Some models were also estimated using the number of individuals in each category, but there was little difference in the results. Each individual may have more than one type of disability.

[20] OLS estimates are available from the authors.

[21] Seventy-seven percent of disabled adults are physically disabled.

[22] Table 1 and subsequent results do not give estimates for the intercepts and the other demographic variables, these are available from the authors.

[23] The White corrected covariance matrix is used in the calculation of within-equation test statistics.

Table 1
Non-linear and non-IB share equations; GMM ($nm = 5060$)

	Fuel	Transport	Services	Food	Alcohol	Clothes	Other
LNY	−0.3315	0.5780	0.0236	−0.5307	0.1863	−0.0173	0.0917
	(−4.408)	(3.535)	(0.174)	(−4.337)	(1.807)	(−0.167)	(1.127)
LNY2	0.0293	−0.0532	0.0045	0.0427	−0.0198	0.0046	−0.0081
	(3.915)	(−3.229)	(0.329)	(3.506)	(−1.922)	(0.442)	(−0.984)
PHYSICAL	0.7870	−0.3288	0.5584	−0.1773	−0.2321	−0.8094	0.2022
	(2.592)	(−0.673)	(1.355)	(−0.353)	(−0.683)	(−2.317)	(0.715)
*LNY * PHYS*	−0.3075	0.1016	−0.2299	0.0907	0.0845	0.3488	−0.0882
	(−2.387)	(0.474)	(−1.288)	(0.422)	(0.577)	(2.255)	(−0.715)
*LNY2 * PHYS*	0.0297	−0.0067	0.0233	−0.1104	−0.0075	−0.0371	0.0094
	(2.203)	(−0.288)	(1.222)	(−0.487)	(−0.485)	(−2.203)	(0.711)
$\bar{R}^2$	0.395	0.155	0.087	0.408	0.092	0.084	0.019
[R7] Disability effect [$F_{90,95}(3,5031) \cong 2.6$]:							
	10.465	1.663	0.576	0.480	1.152	1.492	0.127
Hausman [$\chi^2_{0.95}(14) = 23.685$]:							
	64.446	49.312	44.981	33.153	22.102	35.350	18.817
Sargan [$\chi^2_{0.95}(2) = 5.991$]:							
	1.447	5.119	2.341	0.474	3.209	11.208	0.161

Note: White correct *t*-ratios in parentheses.

consumption costs associated with disability.[24] However, the *F*-test for the joint significance of variables involving physical disability is significant (at 5 percent) only for fuel. This positive impact of disability on the share of fuel is consistent with disabled individuals facing higher heating costs as a consequence of their restricted mobility. A measure of the severity of disability only approached statistical significance in the fuel equation, and was excluded from the model.[25]

The *t*-ratios for *LNY2 * PHYS* indicate that the IB restriction [R2] cannot be rejected for all goods apart from fuel and clothing. Given this result, in principle only the first method of identifying scales is potentially valid for fuel and clothing. If the scale is independent of the price of either good it can be identified by equating the relevant budget share. A pairwise test of the null that fuel and clothing belong to a demographically separable group gives a Wald statistic of 0.317, which indicates non-rejection.[26] Linear approximations of the log-scale for fuel and clothing have been calculated at

[24] The one exception is services for which the budget and disability effects are both positive.

[25] The severity of disability is measured using a scale constructed by OPCS (Martin et al., 1988), giving a single severity score for each individual in the range 0.5–21.4. The variable used here (*SEVMAX*) is the highest severity score for each household.

[26] However, in addition to the usual proviso that non-rejection does not mean acceptance, note that demographic separability is necessary but not sufficient for price independence.

the sample means and by taking the mean across disabled households. None of these is significantly different from zero.

Table 2 presents estimated coefficients and test statistics for share equations corresponding to an IB version of (5). The budget and physical disability effects that the same sign as the in the non-IB model, and hence show the same pattern of disabled households spending proportionately more on necessities and less on luxuries. F-tests indicate rejection of a linear specification for all except services, clothing and other goods.[27] Again the F-statistic for the disability variables is strongly significant for fuel, and more marginally for transport. Given the failure to reject the null hypotheses of linearity and no disability effect for services, clothing and other goods, it would not be appropriate to identify scales from the estimated non-linear share equations for these goods.[28]

Table 2
Non-linear and IB share equations; GMM ($n = 5060$)

	Fuel	Transport	Services	Food	Alcohol	Clothes	Other
LNY	−0.3481	0.5790	0.0103	0.5240	0.1905	0.0061	0.0861
	(−4.658)	(3.535)	(0.076)	(−4.248)	(1.848)	(0.058)	(1.056)
LNY2	0.0310	−0.0533	0.0059	0.0420	−0.0202	0.0022	−0.0076
	(4.175)	(−3.232)	(0.430)	(3.420)	(−1.966)	(0.206)	(−0.912)
PHYSICAL	0.1533	−0.1867	0.0615	0.585	0.0711	−0.0172	0.0016
	(3.516)	(−2.642)	(1.055)	(0.871)	(1.433)	(−0.350)	(−0.039)
LNY * *PHYS*	−0.0306	0.0395	−0.1273	−0.0124	0.1414	0.0026	0.0005
	(−3.481)	(2.599)	(−1.018)	(−0.897)	(1.433)	(0.244)	(−0.056)
$\bar{R}^2$	0.397	0.155	0.089	0.408	0.093	0.084	0.019
Hausman [$\chi^2_{0.95}(13) = 22.362$]:	63.132	49.023	37.839	30.604	21.834	33.244	18.778
Sargan [$\chi^2_{0.95}(2) = 5.991$]:	1.436	5.167	2.307	0.421	3.204	10.357	0.130
[R4] Price independence [$\chi^2_{0.95}(1) = 3.841$]:	0.290	0.210	–	0.310	0.003	–	–
[R5] Log-scale:	0.4927	0.3708	–	0.1477	0.3496	–	–
	(1.753)	(1.492)		(0.693)	(0.843)		
[R6] Linearity [$F_{0.95}(4,5028) \cong 2.37$]:	18.981	7.180	0.877	6.354	2.218	0.778	0.856
[R7] Disability effect [$F_{0.95}(2,5032) \cong 2.99$]:	12.534	2.999	0.517	1.021	1.916	0.396	0.019

Note: white corrected t-ratios in parentheses.

[27] Although the F-statistic is marginally less than the 5 percent critical value in the alcohol equation, the robust t-ratio for the quadratic term itself is significant.

[28] Linear models have been estimated. In this context, IB is not rejected for services, clothing and other goods and physical disability does not have a significant effect on these share equations. Identification of scales from these estimates is not considered further.

Consistency of the data with an IB version of (6) is tested by the restriction [R3]. The null is rejected for the pairwise comparison of fuel and food with $\chi^2(1) = 7.54$. However there is some ambiguity here, the Wald statistic for the restriction expressed in terms of products rather than ratios is 2.84. Identification of the log-scale by equating shares of a particular good is valid if restrictions [R2] and [R4] hold for that good. The Wald statistics presented in Table 2 do not indicate rejection of price independence for fuel, transport, food nor alcohol. The log-scales for all of these goods are positive, suggesting that physical disability increases costs. The largest and most significant scale is for fuel, with a point estimate of 1.64, implying relative consumption costs of 64 percent for a two-adult household. However, the validity of this scale must be qualified by the rejection of the IB restriction for this equation. The point estimate of the scale derived from the transport equation is 1.45. The poorly determined estimated for food and alcohol reflect the low significance of the disability variables in these equations.

While our estimated scales, based on fuel and transport, suggest sizeable consumption costs of disability, considerable caution should be exercised in interpreting these results as the estimates are rather imprecise. None of the log-scales is significantly different from zero (at 5 percent). This may be because preferences display demographic homotheticity (Dickens et al., 1993), but there are reasons to doubt this conclusion. Interpretation of these results raises a problem with using non-linearity and heterogeneity of the Engel curves to identify the equivalence scales in the context of disability. Although the individual coefficients are well determined in the fuel and transport equations, there may be a lack of independent variation and hence a lack of identifying information in the higher order and interaction terms.[29] This affects the power of the tests for price independence, preferences and demographic separability, as well as the precision of the estimated scales.[30]

A related issue is the relative sparsity of observations with disabled individuals. Shakoto and Grossman (1982, p. 194), in a US study of the impact of disability on educational choices, argue that the information contained in 'disabled' observations tends to be swamped by the large majority of 'non-disabled', inflating the standard errors and limiting the power of tests based on the disability variables. This may be compounded by the fact that the FES, being a household survey, is known to under-represent the severely disabled (Matthews and Truscott, 1990).

[29] In this respect, the clear rejection of [R6] and [R7] for the fuel equation is encouraging. This leads us to concentrate on identifying the scale from the fuel share. Of course, this requires that price independence and IB are appropriate assumptions.

[30] To some extent, the contrast between the standard errors for the coefficient estimates and for the log-scales, in the fuel and transport equations, may be due to the use of the delta method to approximate the latter.

5. Discussion

As an exercise in measurement, the equivalence scale methodology could be applied to any demographic characteristic that affects household spending patterns. Traditionally, applications have concentrated on equivalence scales for children, but interpretation of these scales as indicators of household welfare has often been challenged on the grounds that parents have revealed a willingness to tradeoff the costs against the direct benefit of having children. This argument does not have the same force with respect to disability since, in general, people do not choose to become disabled. Whilst caveats might be added concerning individuals who knowingly choose an unhealthy lifestyle, the fact that the majority do not choose disability and the associated costs provides a justification for attaching normative significance to equivalence scales for disability. In practice, the existence of social security benefits designed to reimburse consumption costs associated with disability indicates widespread support for providing compensation. In the United Kingdom in 1990/91 the Treasury spent £2.2 bn on the benefits targetted at the additional costs of disability (Berthoud, 1991). Whether such a sum is adequate to cover the relevant costs is an important policy issue.

In our empirical analysis physical disability is shown to have a significant effect on household fuel and transport expenditures. Also, disabled households appear to spend a greater share of their budgets on necessities and less on luxuries. Our estimated scales suggest positive consumption costs of disability. However, it has proved difficult to obtain precisely determined estimates of scales for physical disability. This may be because the estimated Engel curves are based on broad expenditure categories. More disaggregation of expenditures, concentrating for example on substitution within different types of fuel and transport, may reveal more specific effects.[31] At the aggregate level there may be scope to investigate the impact of disability on purchases of durable goods and household savings. Recent studies have pointed out that if changes in household composition influence the allocation of savings and consumption over time then life-cycle consistent equivalence scales should be investigated (Banks et al., 1991; Pashardes, 1991). In their descriptive analysis of the FES, Matthews and Truscott (1990) observe a difference in savings between disabled and non-disabled households and suggest that this may be explained by differences in permanent income. This argument could be developed to analyse the link between disability, income uncertainty, and savings.

[31] Information on price variation could enhance the estimation of scales. But no data are available in the United Kingdom.

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Appendix

Table A1
Variables used in estimated Engel curves

Dependent variables (mean):
Budget shares of fuel (0.095), transport (0.188), services (0.143), food (0.302), alcohol (0.068), clothing (0.093), other goods (0.111).

Independent variables:		MEAN	S.D.
LNY	natural logarithm of total expenditure LNY squared	4.839	0.644
LNY2			
	Along with interactions of LNY and *LNY2* with PHYSICAL, NADULTS NKIDS, and *FEMALE*, and interactions of *LNY* with *MENTAL*, *HEAR*, *SIGHT* and *OTHER*		
PHYSICAL	dummy for individuals with a physical disability	0.075	0.263
MENTAL	dummy for individuals with a mental disability	0.032	0.176
HEAR	dummy for individuals with a hearing disability	0.046	0.210
SIGHT	dummy for individuals with a sight disability	0.017	0.130
OTHER	dummy for individuals with an other disability	0.023	0.149
NADULTS	number in household aged 16+ minus 2	0.007	0.736
NOLD	number in household aged 16+ minus 60+	0.134	0.422
NKIDS	number in household aged 16+ minus 15−	0.847	1.091
AGE	age of head of household (HoH)	40.98	11.94
AGE2	$age^2/10$	182.2	101.3
FEMALE	dummy for female HoH	0.162	0.368
QTR1	dummy for interview in January/February/March	0.261	0.439
QTR2	dummy for interview in April/May/June	0.258	0.438
QTR3	dummy for interview in July/August/September	0.238	0.426
TENLA	dummy of local authority rented accommodation	0.236	0.425
TENRENT	dummy for private rented accommodation	0.105	0.307
LONDON	dummy for residence in Greater London	0.115	0.319
WORKERS	number of earners in household minus 1	0.486	0.935

Other variables:

SEVMAX	highest severity of disability score in household
HOLDNET	household net income (used in IV estimation)
	– additional demographics are dummies for Wales and Scotland

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