A Monetary Approach to Capability Measurement of the Disabled – Evidence from the UK

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Abstract

In this paper we attempt to assess empirically the capability set of the disabled. We formulate the assumptions under which capability can be interpreted as needs-adjusted disposable household income, and use equivalence scales methodology to estimate it for households in the UK. We identify a positive cost of disability to the households and state, to what extent a disability can reduce an individual's capability set. The use of the derived capability measure instead of traditional income in poverty measures leads to a dramatic increase of poverty among the families with disabled members.

JEL Classification: D1, I12

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1 Introduction

Individuals with a disability usually have a double disadvantage: on the one hand, they earn less income than non-disabled, because they are not employable or are employable with difficulty, or have to work in jobs with little pay (e.g. charities). On the other hand, because of their special needs, they have more difficulty to extract welfare from their resources than non disabled persons. This becomes obvious when an individual bound to a wheelchair needs a specially adjusted car to be mobile, compared to a standard car for a non-disabled; but is also present when special bathrooms, ramps, stair lifts, Braille

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books or computer hardware need to be bought to perform certain activities non disabled can do without additional help.

In standard applied economic research on poverty or inequality, usually only the lower income of disabled individuals is reflected. Individual welfare levels are usually measured as income or expenditure, which does not allow to account for the second disadvantage, the higher consumption costs faced by these individuals. The capability approach developed by Sen ([26], [27], [28]) offers an alternative to these measures, which has advantages in interpersonal comparability and captures a wider concept of welfare. The aim of this paper is to develop an individual welfare measure based on the capability approach, which captures the additional needs of families with disabled members.

The core concepts of Sen's approach are functionings and capabilities. Sen (Sen [29]:5) defines functionings as an achievement of a person, i.e. what he or she manages to do or to be. Hence, functionings comprise an individual's activities and states of being, e.g. being in good health, being well-sheltered, moving about freely, being employed, being educated. Capability is a derived notion, and reflects the various combinations of functionings he or she can achieve, i.e. the person's freedom to choose between different ways of living.

Formally, the evaluation of an individual's welfare level according to the capability approach involves the analysis of a capability set, X_i, which is defined over the different potential activities or states of being $\mathbf{b}$ of individual i

$$X_i\left(Q_i\right) = \left\{\mathbf{b}_i | \mathbf{b}_i = f_i\left(c\left(\mathbf{q}_i\right), \mathbf{z}_i\right) \quad \forall \quad f_i \in F_i \text{ and } \forall \quad \mathbf{q}_i \in Q_i\right\} \tag{1}$$

where $\mathbf{q}_i$ is a vector of market and non-market goods and services chosen by the individual, $c(\cdot)$ is a function that maps goods into the space of characteristics[1], $\mathbf{z}_i$ is a vector of personal characteristics and societal and environmental circumstances, f_i is a function that maps characteristics of goods into states of being or activities $\mathbf{b}_i$, conditional on $\mathbf{z}_i$. X_i is the set of all possible $\mathbf{b}_i$, given the resource constraint Q_i (Sen [26]:7-10). The space of functionings $\mathbf{b}$ is the space of states of being and activities, while the space of capabilities X is the space of *potential* functionings. The functioning space is related to the goods and characteristics space through the personal conversion function f_i. The capability space is related to the functioning space in that it comprises all functionings an individual can potentially achieve. It is thus the individual's choice set, and could be interpreted as an augmented budget set, which also takes account of non-market goods and services, and non-monetary constraints.

The characterising differences between Sen's approach and the standard approach to individual welfare evaluation are (1) that the vector $\mathbf{q}_i$ includes non-market as well as marketable goods and services, (2) that individuals with the same resources can achieve different levels of standard of living $\mathbf{b}$, because they have different conversion factors or needs $\mathbf{z}$ (e.g. some are disabled and some are not), and (3) that choice is of intrinsic value (see Kuklys and Robeyns [15]).

Empirical applications of the capability approach have focussed on the evaluation of $\mathbf{b}_i$, the vector of achieved functionings of an individual (see Kuklys

[1] in the sense of Gorman [12] and Lancaster [16].

and Robeyns [15]). Few, if any, attempts have been made to estimate an individual's capability set.[2] In this paper, we show under which assumptions a capability set can be reinterpreted as needs-adjusted disposable income, or as Deaton and Muellbauer ([10], p.226) call it, a "consumption opportunity set". We then use the equivalence scale methodology to adjust disposable income for the special needs implied by a disability. In an application to poverty analysis we show the impact of measuring welfare in terms of our empirical capability set compared to standard income measures.

2 Capability as a Consumption Opportunity Set

Simplifying equation (1), and assuming all goods to be marketable, we can write

$$X_i\left(Y_i\right) = f\left(Y_i | \mathbf{z}_i\right) \tag{2}$$

where Y_i is the disposable income of individual i and $\mathbf{z}_i$ a vector of conversion factors that determines the average rate of converting income into functionings. The capability set is hence a function of the income set, given social, environmental and individual conversion factors. Assuming that f is monotonic, by inverting (2) we can write

$$\left(Y_i\left(X_i\right) | \mathbf{z}_i\right) = f\left(X_i\right). \tag{3}$$

Now, if $(Y_i|\mathbf{z}_i)$ can be identified, a monotone transform of the capability set X_i is also identified. A similar identification problem lies at the heart of the literature on equivalence scales, namely the identification of $(Y_h|\mathbf{z}_h)$, where Y_h is the disposable income of a household and $\mathbf{z}_h$ is a vector of needs of the household. In this paper, we will use an equivalence scale strategy to identify the capability set of disabled people, however, first we want to clearly state and justify the assumptions involved in interpreting needs-adjusted disposable income as a capability set.

First, we assume that all goods affecting welfare are marketable. We also implicitly assume that all consumers face the same consumer prices and market imperfections. These assumptions are strong, as capability in its original sense precisely covers non-market goods and services in the resource constraint. However, we believe that in the context of a developed nation like the UK, this assumption is more justifiable than in a nation where markets are hardly developed. Second, we assume that more income leads to more capability, i.e. we have an analogue to the non-satiation assumption in standard welfare economics. This is justifiable by the fact that more income can lead to a greater range of choice as well as a higher quality or quantity in each of the elements of choice, i.e. the functionings. Third, by adjusting the opportunity set directly for needs, without estimating the conversion functions, we assume that the effect of

[2] For an evaluation of individual capability in small scale development projects see Alkire [1]. Burchardt and LeGrand [8] have assessed whether unemployed individuals have the capability to work.

the conversion factor is equal across functionings, or at least, that the effect can be expressed in average terms. Fourth, when interpreting the needs-adjusted disposable income as a capability set, we have to take into account that it is only a monotone transform. The numerical values of the true capability set will differ from those of the needs-adjusted disposable income. However, the ordering of individuals in a given distribution is the same (see also Atkinson [2]). Finally, as we use household equivalence scales, we are assessing the capability at the household level. However, by focussing on those disabled living as singles, we can empirically determine their individual-level capability set.

3 Disability as a Conversion Factor

From the capability perspective, individuals suffer from lower income generating capacity and, on top of that, from a lower capacity to convert resources into functionings. This implies that disabled individuals have a smaller capability set, both because the level of functionings they might be able to achieve is lower, and the range of potential functionings is reduced. It is important to note that our approach does not address life satisfaction or levels of utility of disabled individuals compared with non-disabled, as similar consumption opportunity sets can coincide with very different levels of subjective utility, particularly in the case of disabled individuals. Instead, we attempt to perform an assessment of the range of consumption choice of families with and without disabled members. Disability as an additional needs factor has also the advantage that it is - apart from some pathological cases - rarely the outcome of choice, i.e. it is immune to Pollak and Wales' critique described in section 4.2.[3]

Two papers exist in the literature that aim to assess the extra consumption cost of disability with the equivalence scale method, namely Jones and O'Donnell [14] and Zaidi and Burchardt [30]. Jones and O'Donnell identify this cost with mixed success as their disability indicators are not significant in any of the regressions. Zaidi and Burchardt have recently assessed the cost of disability for a household by using a standard of living methodology akin to the psychometric method explained below. In section 6, we will compare our results to theirs.

4 Equivalence Scales

Equivalence scales identify needs-adjusted household income, and are defined as a vector $m(\mathbf{z})$ of H normalising constants (H = number of households in the sample) which turn disposable household income y^h into equivalent (needs adjusted) household income $y^{he} = \left(y^h|\mathbf{z}_h\right)$, by taking account of a vector $\mathbf{z}_h$

[3] I thank Helene Couprie for pointing out a paper by Heckman which models the choice of being registered as disabled. As we rely in this paper on this kind of data, we can consider the results as a lower bound on disability (the choice to register or not as disabled is only present if individuals are actually disabled).

of different needs of the household. The scales are calculated with respect to a reference household, r, at a reference welfare level, $\overline{w}$.

$$m^h(\mathbf{z}) = \left.\frac{y^{he}}{y_r^h}\right|_{\overline{w}}, \quad h = 1, ...H.$$

For example, if a household of four has the same income as a single household, say, each GBP 20,000, the equivalent income of the family is lower than that of the reference household, because they have more mouths to feed with the same money. Imagine, m^h (4 family members) $= 2.3$, then the equivalent household income for the family of four is GBP 20,000/2.3 =GBP 8695.Similarly, consider two single households, one of them with a disabled individual, the other healthy, with an income of GBP 15.000 each. If m^h (disability) $= 1.5$, then the equivalent income of the person with a disability is GBP 10,000. One could also say that his capability set as defined in this paper is reduced by 1/3.

Two main econometric ways of arriving at equivalence scales $m(z)$ exist, which will be described in detail in the next two sections: a demand based approach, and a psychometric approach. In section 4.3, we will discuss the difficult issue of what should be included in the vector $\mathbf{z}_h$.

4.1 Consumption-based Scales

The demand-based methodology estimates equivalence scales from expenditure patterns of families. These scales are derived from standard consumer theory. Assume that household h maximises its utility u^h over a vector of goods $\mathbf{q}$, conditional on needs $\mathbf{z}$ and subject to the budget constraint $y^h = \mathbf{p}.\mathbf{q}$. The estimation of the demand system $\mathbf{q}$ allows the recovery of the cost functions $c\left(u^h, \mathbf{p}, \mathbf{z}^h\right)$ by Shepard's lemma; and the equivalence scale $m^h(\mathbf{z}, \mathbf{p})$ can be expressed as the ratio of a household's cost function with respect to the reference household's cost function

$$m^h(\mathbf{z}, \mathbf{p}) = \frac{c\left(u^h, \mathbf{p}, \mathbf{z}^h\right)}{c\left(u^r, \mathbf{p}, \mathbf{z}^r\right)} = \left.\frac{c\left(\mathbf{p}, \mathbf{z}^h\right)}{c\left(\mathbf{p}, \mathbf{z}^r\right)}\right|_{u^r} \tag{4}$$

As price data is often not available, these type of equivalence scales are routinely calculated by estimating Engel curves

$$w_i = f\left(\log\left(y^h\right), \mathbf{z}^h\right) \tag{5}$$

where w_i is the expenditure of the ith good as a fraction of household income. To identify these scales, a reference welfare level must be defined; it is assumed that the expenditure share of the good i is a good indicator of the household's welfare. At the chosen reference level of the ith good's share, it is then possible to calculate the additional income that any household requires to be as well of as the reference household.[4]

[4]It has long been recognised that the food share is not necessarily a good indicator of welfare (see Deaton [11] for a detailed analysis, but also Perali [21] for a defense of the method). The

Apart from problems relating to the appropriateness of the reference welfare indicator in use, these type of equivalence scales are plagued by identification problems. For example, Pollak and Wales [22] have argued that the cost function and hence equivalence scale cannot be uniquely recovered from demand information, as the corresponding utility function itself can be a function of the characteristics of the household. This is, for example, the case of planned children: Parents presumably plan and subsequently have children because they increase their level of utility. In that case, the utility function is of the form

$$u^h = F\left(u^h\left(\mathbf{q}, \mathbf{z}^h\right), \mathbf{z}^h\right). \tag{6}$$

where F is some monotone transform. Both utility functions $u^h = u\left(\mathbf{q}, \mathbf{z}^h\right)$ and (6) imply the same cost function. The direct increase in utility through children cannot be identified by these methods based expenditure data because only demands *conditional* on a household's characteristics can be estimated. Blundell and Lewbel [6] have argued that, once a true (unconditional) equivalence scale is given for one price regime, conditional equivalence scales can be used to "recover the true values of all equivalence scales in all other price regimes". They suggest (p.59) that psychometric data may be used to help solve the identification problem. Coulter, Cowell and Jenkins ([9],p. 96) agree with Van Praag and Van der Sar [24] that the *psychometric approach* might be a useful complement to the traditional one.

4.2 Psychometric Equivalence Scales

The psychometric approach is the second way of arriving at econometrically estimated equivalence scales. It originated in Van Praag's [23] work on the individual welfare function of income and has been applied for the estimation of equivalence scales by Van Praag, Hagenaars and Van Weeren [25], and recently by Bellemare, Melenberg and van Soest [4]. Subjective information on income satisfaction is used to estimate a household "utility" function u^h of income y^h, conditional on needs $\mathbf{z}^h$ *directly* so that

$$u^h = u\left(y^h, \mathbf{z}^h\right). \tag{7}$$

The rationale behind this is that income utility as a function of household income (the income satisfaction - income curve) is shifted inwards by increasing needs. At a given reference level of utility u^r, the scale can be expressed as

$$m^h(\mathbf{z}) = \frac{Y^{eh}}{Y^r} = \frac{u^{-1}\left(u^h, \mathbf{z}^h\right)}{u^{-1}\left(u^r, \mathbf{z}^r\right)} = \left.\frac{u^{-1}\left(\mathbf{z}^h\right)}{u^{-1}\left(\mathbf{z}^r\right)}\right|_{u^r}$$

This method suffers from two problems. Firstly, it is viewed suspiciously by economists from the revealed preference school, because it is based on what

related *isoprop method* uses a basket of goods. The Rothbart method uses the level of *adult goods* expenditure in the household. In that case, the Engle curves are upward sloping. There also exist commodity specific scales, such as Barten scales. Deaton provides an overview of all methods based on expenditure data and their respective advantages.

individuals *say* rather than their *actions*. However, in other areas of economic research the value of stated preference data has been recognised and is used for policy analysis.[5] The second problem is related to the fact that some variables in the household income satisfaction function are correlated with utility in a non-policy relevant manner. In other words, some factors might affect income satisfaction separately from the effect they have on household costs; for example, a person might be depressed, and therefore never be happy with any household income.This is related to the problem in the estimation of consumption scales that some of the factors affecting needs are compensated by a substitution effect[6]. We assume in this paper that the presence of a disability has a negligible effect on income satisfaction apart from the cost channel.

4.3 Needs and Preferences

In principle, a wide range of needs $\mathbf{z}^h$ could be taken into account when adjusting household income and identifying capability sets. In fact, for the identification of true capability sets, all differences in conversion factors should be taken into account. In this context, Blackorby and Donaldson [5] point out that a different equivalent income could be derived for each individual, but unfortunately, practical considerations make this impossible. In practice, equivalence scales always have to be identified for a group of households with the same needs, to guarantee a sufficient cell size for econometric estimation; in other words, the set of needs has to be reduced. On the other hand, both the consumption based and the psychometric equivalence scales have to tackle the problem that consumption patterns and income satisfaction might be affected by variables other than what we call needs or conversion factors, i.e. the income satisfaction - income curve might be shifted outwards or inwards by other than conversion factors. For simplicity, we call these factors preferences. While we do not intend to establish a differentiation between needs and preferences which is valid for all types of analysis, and do not want to raise the philosophical issues involved in this differentiation, for practical purposes our approach requires the distinction between factors that require adjustment and those which do not. We follow the literature in assuming that –besides disability– household size and composition are those factors most constraining the households' consumption opportunities and hence are those variables for which disposable income has to be adjusted. While we include variables such as sex, level of education, house ownership and marital status in the econometric estimation for consistency purposes, we disregard them in the calculation of the scales; this is reasonable as these variables can be assumed to be uncorrelated with disability, our main target in this paper.

[5] See, for example Louviere, Hensher and Swait [17] for examples in transport policy, marketing, and environmental evaluation. See also Manski [18] for an assessment of the usefulness of psychometric data in econometric applications.

[6] For example, in the case of adult good scales, the level of alcohol or cigarette consumption might fall when children are present, because parents are breastfeeding or taking their role as a role model for their children into account. Also, expenditure on going out might be less once small children are present, because more time is spent at home together. This is the effect described above, where factors that affect needs also impinge on preferences.

5 Estimating the Capability Set

In this section we first specify the empirical model to be estimated. Subsequently we describe the data and the estimation method, and address specific estimation and specification issues.

5.1 The model

We assume that overall household utility u^h is additively separable in utility u_c^h derived from consumption $\mathbf{q}$ and utility derived from other sources, u_o^h such as from being healthy, or having children.

$$u^h = u_c^h(\mathbf{q}) + u_o^h(health, children, ...) \tag{8}$$

In this paper, we are only interested in the first term of the right hand side of (8), i.e. the utility that a household derives from its consumption capacity. We further assume that we cannot represent consumption as a composite consumption good, as households differ in needs. We therefore separate household consumption, $\mathbf{q}^h$, into basic household consumption, $\mathbf{q}_b$, household consumption due to bigger household size, $\mathbf{q}_s$ and household consumption due to other needs, $\mathbf{q}_z$, so that the household maximises

$$u_c^h = u_c^h(\mathbf{q}_b, \mathbf{q}_s, \mathbf{q}_z) \text{ subject to } (\mathbf{q}_b + \mathbf{q}_s)\,\mathbf{p} + \mathbf{q}_z \mathbf{p}_z = y^h \tag{9}$$

where $\frac{\partial u_c^h}{\partial c_i} > 0$, $i = b, s, z$. As the different components of $\mathbf{q}^h$ are not separately observable in practice, we work with the reduced form income satisfaction equation

$$u_c^h = u_c^h(y^h, \mathbf{s}, \mathbf{z}). \tag{10}$$

This corresponds to a income satisfaction function defined over income conditional on household size and composition and a disability indicator. Here, we follow Melenberg and van Soest [20] and Bellemare, Melenberg and van Soest [4] in using a log income satisfaction function of net household income. The empirical model to be estimated consists of a log linear model

$$u_c^h = \beta_0 + \beta_1 \ln y^h + \beta_2 \mathbf{z}^h + \beta_3 \mathbf{x}^h + \varepsilon^h \tag{11}$$

where $\mathbf{z}$ is a vector of variables indicating household size and composition and disability, $\mathbf{x}$ is a vector of preference shifters, and ε^h is a normally distributed error term. u_c^h is interpreted as the level of satisfaction with income. Equation (11) can then be estimated from household survey data.

Real household income y^{he} is defined as the income that would allow household h to achieve the same level of income satisfaction as the reference household r. The equivalence scale is hence defined as the ratio of each household's h real income and the reference household's income. We use a one-adult household without disability as the reference household.

Let household h's and the reference household r's utility function be given respectively, by

$$\begin{aligned} u_c^h &= \beta_0 + \beta_1 \ln y^h + \beta_2 \mathbf{z}^h + \beta_3 \mathbf{x}^h + \varepsilon^h \\ u_c^r &= \beta_0 + \beta_1 \ln y^r + \beta_2 \mathbf{z}^r + \beta_3 \mathbf{x}^r + \varepsilon^r . \end{aligned} \tag{12}$$

Estimating the parameters and setting $u^h = u^r$ as in the definition for equivalence scales, and dropping the element related exclusively to preferences ($\beta_3 \mathbf{x}$), we arrive at[7]

$$\hat{\beta}_1 \left(\ln y^h - \ln y^r \right) = \hat{\beta}_2 \left(\mathbf{z}^r - \mathbf{z}^h \right).$$

The equivalence scale is then

$$m^h (\mathbf{z}) = \frac{y^h}{y^r} = \exp \left\{ \frac{1}{\hat{\beta}_1} * \hat{\beta}_2 \left(\mathbf{z}^r - \mathbf{z}^h \right) \right\}. \tag{13}$$

5.2 The Data

The data used in this study are taken from the British Household Panel Survey (BHPS), in scope and purpose very similar to the German Socio-Economic Panel (GSOEP). Since 1992, the BHPS has been conducted as an annual panel survey of a representative sample of approximately 10,000 individuals over the age of 16 in more than 5,000 households. A household questionnaire is answered by the head of household and individual questionnaires answered by all individuals over 16 which are members of this household. The individuals also answer a 'self-completion questionnaire', which provides information on potentially sensitive topics which might be vulnerable to the influence of family members' presence during the completion. In case of individuals which cannot be contacted directly or are too ill to fill in their own questionnaires a much shorter *proxy interview* is conducted with a family member. In case a person cannot be contacted otherwise, a telephone interview is used.

As the telephone and proxy interviews do not provide information on income satisfaction, they are excluded from the analysis. For the estimation in this paper, we used household level information provided for the years 1996-1999. As income satisfaction is reported on the individual level, we chose the head of household's satisfaction level as the relevant one for our analysis; similarly, the other individual level variables included in $\mathbf{x}^h$ are those characterising the head of household.

About 5% of the records contain missing data. We have used listwise deletion, under the assumption that the data is missing randomly. This, together with the fact that some household heads did not respond in all panel waves, leads to the estimation of an unbalanced panel. We retained only those households where the household head did not change from 1996 to 1999. The analysis is thus based on just under 3000 households observed over four years.

[7] As described in section 4.3, the $\mathbf{x}$ are preference shifters, included to estimate the parameters consistently, and should not affect the calculation of the scales themselves, which are exclusively based on needs.

Below, we describe the variables used in the analysis. 'Satisfaction with household income' and 'household income' are described in detail. As described, the identification of needs is based on an *a priori* partition of the set of variables. The variables indicating needs are household size, the number of children and their age group and number of adults, and the number of registered disabled living in the household. Variables indicating preference shifters are listed in the last paragraph. Tables 1 to 3 summarise the main features of these variables.

- *Satisfaction with household income* u^h. This variable contains the answer to the question "How satisfied are you with your household income". This variable has seven categories from 0 (not satisfied at all) to 6 (completely satisfied).[8]
- *Household Income* y^h. The income variable used in this analysis is the annual net household income as provided by Jenkins [3], deflated with the corresponding retail price index to 1996 prices. The net household income includes disability and child benefits so that the scales calculated below have to be interpreted correspondingly.
- *Household size*: The number of persons living in the household.
- *Number and age group of children:* Number of children in each age group living in the household.
- *Number of adults:* Number of adults living in the household.
- *Number of disabled individuals:* Number of those individuals which are registered disabled living in the household. The inclusion of the number of disabled people is 'additional': a disabled person enters the vector $\mathbf{z}$ twice, once as a family member in his or her age group, and once as a disabled member. This reflects that the cost is born by the household as a whole. Thus, strictly speaking, the scales below have to be interpreted as the cost of disability, not the cost of a disabled member to the household.
- *Preference shifters*: age, dummies for sex (1 if male, 2 if female), marital status (1 if separated, divorced or living as couple, 0 otherwise)[9], education level (1 if highest education level is lower than GCE A-levels, 0 otherwise) and job status of household head (1 if unemployed or inactive, 0 otherwise), housing tenure (1 if owned without mortgage, 0 otherwise), and time effects.

Tables 1 to 3 include some simple descriptive statistics which illustrate how income satisfaction declines with average income and increasing household size and number of disabled members of the family.

[8] The original coding was from 1 (not satisfied at all) to 7 (completely satisfied). We recoded this variable for computational purposes.

[9] In the original estimation, there was a dummy for each marital status. This restriction was not rejected by the data.

Table 1: Descriptive Statistics of Income and Income Satisfaction

Year	Income				Income Satisfaction	
	mean	s.d.	min.	max	mean	s.d.
1996	16610	11051	60	140,993	3.37	1.72
1997	17059	11313	0	110,483	3.51	1.70
1998	17452	13085	0	264,361	3.64	1.60
1999	16982	12870	0	266,126	3.58	1.58

In table 1, we observe that average yearly net household income inclusive of benefits in prices of 1999 lies between GBP 16,610 in 1996 and GBP 17,452 in 1998. In 1999 it sinks slightly to GBP 16,982. The most striking feature of this variable is that 5 households each year report zero income, and about 40 households per year report an annual net income inclusive of benefits which is lower than GBP 3000. Those households with zero income were not included, because the logarithm of income is not defined in this case. A transformation of the data (adding 1 pound per year to each household, which seems an innocent transformation), did not produce substantially different results.[10] The households with yearly net income of less than GBP 3000 were included as, according to the data depositors, this is a reasonable picture of reality. Many households receive non-reported in-kind benefits from relatives, and do not claim benefits that they are entitled to. Furthermore, a high proportion of these households report that they have paid off their mortgage and are single households in pension age, implying that GBP 500 per month is sufficient for survival.

Although income satisfaction is an ordinal variable, for informative purposes, we report means and standard deviation as if it was cardinal. The average income satisfaction rises from 1996 to 1998 with average income, and sinks slightly with average income in 1999.

Table 2 shows the yearly net income per capita of households according to the number of disabled members. Income per capita for families without disabled members is on average 19.8% higher than those of families with at least one disabled member. In table 3 we present yearly net income per capita and satisfaction with income depending on the household size. Both average income per capita and average satisfaction with income decrease with household size. Average income per capita, however, is only a rough approximation of equivalent income, and would not reflect any economies of scale in the household; we would therefore expect average satisfaction with income to decrease slower with household size than average income per capita.

[10]Interestingly enough, the households with zero income report almost average levels of satisfaction with their income. This is either an example of extreme adaptation to their circumstances, or, alternatively, there are mistakes in the data collection process, or the income they receive is in very irregular intervals (larger than one year). Given the small number of individuals reporting zero income, we consider it safest to drop these observations from the sample.

Table 2: Households with Disabled Members and Average Income

	Year				Avg. income
No. Disabled	1996	1997	1998	1999	per capita
0	2747	2699	2743	2647	8236
1	217	250	239	260	6926
2	14	14	14	14	6448
3	0	0	1	1	3482
Total	2978	2963	2997	2949	8117

Table 3: Household Size, Income per Capita and Satisfaction with Income

No. Obs.	Year				Avg. Income	Avg. Satisfaction
Size	1996	1997	1998	1999	per capita	with Income
1	828	819	846	851	9384	3.64
2	992	991	1010	994	9148	3.61
3	464	458	430	428	7464	3.32
4	471	484	501	481	5990	3.45
5	174	165	162	157	4634	3.43
6	36	35	35	25	3614	3.05
7	12	9	9	9	3022	2.89
8	1	2	4	4	2023	2.60
Total	2978	2963	2997	2949	8117	3.53

5.3 Econometric Estimation and Model Specification

Given the categorical nature of the dependent variable in our model and the ordinal nature of utility, which is measured by this dependent variable, the appropriate technique for estimating equation (11) is an ordered probability model with a panel structure.[11] Assuming the error term to be normally distributed, we estimate ordered probit models. In the estimation of these models, two types of heterogeneity exist, which are not entirely taken into account by the preference indicators included in the regression, namely scale heterogeneity and other unobserved heterogeneity. Scale heterogeneity is related to the ordinality of the dependent variable, and to the fact each respondent might understand the satisfaction scale differently. However, even if the individuals were using the same implicit scale, there is still a possibility of unobserved heterogeneity in the regression. For both reasons, we will take advantage of the available data structure to estimate a panel model which takes into account this unobserved heterogeneity. We estimate both a random and a fixed effects ordered probit model, and compare them to a pooled ordered probit model, which treats the data as a single cross section. In the following two subsections, we describe briefly the ordered probit model and its panel version. We then give a summary of the final model specification and some expectations for the results.

5.3.1 The Ordered Probit Model

The response to the question "How satisfied are you with your income" can be viewed as the outcome of an underlying metric regression. Utility is usually assumed to be a continuous variable, but is observed only in the categories provided in the questionnaire. We assume that the individuals choose the category which most closely represents their own feelings. For simplicity of exposition, let $\mathbf{x}$ denote those factors which influence satisfaction with household income, the level of income, needs and preferences, i.e. the matrix of all exogenous variables. Then the income satisfaction function can be written

$$u_c^* = \mathbf{x}'\beta + \varepsilon \tag{14}$$

where ε is a normally distributed error term with mean 0 and variance 1, and u_c^* is the underlying, continuous utility of monetary income, which is unobserved. What we do observe is

$$\begin{aligned} u_c &= 0 \text{ if } u_c^* \leq 0 \\ u_c &= 1 \text{ if } 0 < u_c^* \leq \mu_1 \\ u_c &= 2 \text{ if } \mu_1 < u_c^* \leq \mu_2 \\ &\ldots \\ u_c &= 6 \text{ if } \mu_5 < u_c^* \end{aligned} \tag{15}$$

[11] Although a seven-category dependent variable is a borderline case in that it could possibly be approximated by a linear regression, preliminary estimates for such models have exhibited considerably higher standard errors than those tailor-made for discrete variable models.

The μs are unknown parameters (threshold parameters) to be estimated with the β. Given the assumptions for the error term, we arrive at the following probabilities

$$\begin{aligned}
\Pr(u_c = 0|\mathbf{x}) &= \Phi(-\mathbf{x}'\beta) \\
\Pr(u_c = 1|\mathbf{x}) &= \Phi(\mu_1 - \mathbf{x}'\beta) - \Phi(-\mathbf{x}'\beta) \\
\Pr(u_c = 2|\mathbf{x}) &= \Phi(\mu_2 - \mathbf{x}'\beta) - \Phi(\mu_1 - \mathbf{x}'\beta) \\
&\ldots \\
\Pr(u_c = 6|\mathbf{x}) &= 1 - \Phi(\mu_5 - \mathbf{x}'\beta)
\end{aligned} \tag{16}$$

For all probabilities to be positive, it is required that $0 < \mu_1 < \mu_2 < ... < \mu_7$.

This simple probit model treats the data as a single cross section. This makes estimation straightforward, and very attractive: to our knowledge, all psychometric equivalence scales in the literature are based on cross sectional estimation techniques. The disadvantage of this model lies in that it neglects individual heterogeneity in the scale of u_c^* and u_c. We therefore suggest to estimate additionally a random and fixed effects ordered probit model.

5.3.2 Random Effects in the Ordered Probit Model

The random effects model postulates a particular structure on the error term ε in equation (14). For the ordered probit panel model, equation (14) becomes:

$$u_{it}^* = \mathbf{x}_{it}'\beta + \varepsilon_{it} \tag{17}$$

where i indicates the household and t the time dimension of the variables, and

$$\varepsilon_{it} = v_{it} + \eta_i$$

η_i is the unobserved, individual-specific heterogeneity, which is assumed to be randomly distributed, v_{it} is the normally distributed error term. This is a reasonable assumption in so far as our observations consists in a sample of households randomly drawn from a large population. This random draw allows to conclude that the unobserved heterogeneity is also random.

In the ordered probit random effects model we make the following assumptions:

$$\begin{aligned}
E[v_{it}|\mathbf{X}] &= 0; \mathrm{Cov}[v_{it}, v_{is}|\mathbf{X}] = \mathrm{Var}[v_{it}|\mathbf{X}] = 1 \text{ if } i = j \text{ and } t = s, 0 \text{ otherwise} \\
E[\eta_i|\mathbf{X}] &= 0; \mathrm{Cov}[\eta_i, \eta_j|\mathbf{X}] = \mathrm{Var}[\eta_i|\mathbf{X}] = \sigma_\eta^2 \text{ if } i = j, 0 \text{ otherwise} \\
\mathrm{Cov}[v_{it}, \eta_j|\mathbf{X}] &= 0 \text{ for all } i, j, t
\end{aligned} \tag{18}$$

where $\mathbf{X}$ is the matrix of all x_{it} in the data. The assumption in line 1 of equation (18), namely that the unobserved heterogeneity is uncorrelated with the included exogenous variables, is strong. To safeguard ourselves as much as possible against this potential problem, we include a wide range of taste shifters as described above in the hope that this takes account of most of the heterogeneity.

From equation (18) it follows that

$$\begin{aligned} E\left[\varepsilon_{it}|\mathbf{X}\right] &= 0 \\ \mathrm{Var}\left[\varepsilon_{it}|\mathbf{X}\right] &= \sigma_v^2 + \sigma_\eta^2 = 1 + \sigma_\eta^2 \\ \mathrm{Corr}\left[\varepsilon_{it}, \varepsilon_{is}|\mathbf{X}\right] &= \rho = \frac{\sigma_\eta^2}{1+\sigma_\eta^2} \end{aligned}$$

The likelihood function can be derived as in the binomial probit panel model.[12]

While this model avoids the heterogeneity bias of the pooled ordered probit model, it does not guarantee consistent estimators if $E\left[v_{it}|\mathbf{X}\right] \neq 0$. The fixed effects ordered probit model avoids this problem.

5.3.3 Fixed Effects in the Ordered Probit Model

The fixed effects model does not make the strong assumption of no correlation between the unobserved and the observed heterogeneity. Equation (14) becomes as in the random effect model

$$u_{it}^* = \mathbf{x}_{it}'\beta + \varepsilon_{it} \tag{19}$$

where

$$\varepsilon_{it} = v_{it} + \eta_{i.}$$

v_{it} is a normally distributed error term, however, in this case n_i is an individual-specific intercept, which is not random. The strong assumptions of the random effects model are therefore not necessary, and in principle, consistent estimation can be achieved. Unfortunately, the fixed effects ordered probit model might be subject to the incidental parameters problem, i.e. that in some cases, in non-linear models the η_i cannot be consistently estimated. This inconsistency translates into an inconsistency of the remaining parameters. While this problem seems to be solved in the latest software,[13] another disadvantage remains, which is akin to a multicollinearity problem: if some independent variables do not vary much across time, they are collinear with η_i, and hence, might not be significant in the fixed effects model.

5.3.4 Other Model Specification and Estimation Issues

In the last three subsections, we have seen that each of the three models has its drawbacks. We therefore estimate all three models, a pooled ordered probit (PA Oprobit), a random effects ordered probit (RE Oprobit) and a fixed effects ordered probit (FE Oprobit). We will compare the results, and interpret them in the light of these drawbacks.

For comparability with existing scales for household size in the literature, and for precision purposes, we will test two model specifications: (1) a simple

[12] see Greene [13] and Baltagi.

[13] LIMDEP 8.0 has a routine to estimate ordered fixed effects models with an unconditional, consistent estimator.

specification, which includes as needs indicators the log of the household size and the number of disabled household members, and (2) a more complex specification which includes the number of adults, number of children in each age group, and the number of disabled in the household. Note that the two models are not nested.

It is to be expected that the estimated equivalence scales reflect a) the economies of scale present in the household, and b) higher costs for those households with disabled members. The economies of scale are due to the presence of fixed costs or indivisibilities: rental costs are usually not doubled when the household size doubles, similarly, certain consumer durables do not need to be bought separately for each household member (for example, a fridge or a laundry machine). Not all costs are fixed, however, as we expect food and possibly clothing to vary with household size. We therefore expect that a model with the log of the household size as a needs indicator would result in a scale which exhibits decreasing increments in costs for each additional household member. A more complex model taking account of the number and age group of each household member would result in a scale that exhibits additional costs which increase with age. To validate our scales for household size and composition, we will compare the results with existing scales for the UK, namely the officially used scales by McClement [19] available in the BHPS, and those by Van Praag and van der Sar [24]. We also report some scales derived for Germany, although strictly speaking, there is no comparability between the scales when different countries with different benefit levels are involved.

Furthermore, we expect that the scales reflect the additional costs the disability inflicts on the household. Our point of comparison are the papers by Jones and O'Donnell and Zaidi and Burchardt, although their disability indicators differ from ours.

Finally, we calculate the standard errors of the equivalence scale using the delta-method

$$\mathrm{var}\left(\mathbf{m}\left(\mathbf{z}\right)\right) = \left(\frac{\partial m\left(\mathbf{z}\right)}{\partial \beta}\right) \mathrm{cov}\left(\beta\right) \left(\frac{\partial m\left(\mathbf{z}\right)}{\partial \beta}\right)' \tag{20}$$

This method is based on a first order Taylor expansion, and hence we have to assume that the estimators (β) are sufficiently close to their true counterparts.

6 Results

This section is divided into three parts. In section 6.1 we describe the estimation results for the simple and the complex specification. As the point estimates of the random effect scales were very similar, with higher standard errors for the RE Oprobit, we report here only the pooled and fixed effects estimates.[14]

We then discuss some examples of resulting equivalence scales and compare them to results in the literature on equivalence scales in section 6.2. Finally, in

[14]This is due to the fact that the likelihood function at the optimum is very flat, reason for which the RE Oprobit model had difficulty converging.

section 6.3 we use our results to illustrate the effect of the cost of disability on poverty analysis in the UK.

6.1 Estimation Results

6.1.1 Simple Specification

A summary of the simple specification models is presented in table 4. The results for both models exhibit the expected signs.[15] Satisfaction of income depends positively on household income and negatively on household size. In the pooled ordered probit the number of disabled individuals in the household also has a significant negative effect on income satisfaction.[16] The fact that this variable is not significant in the fixed effects models is owing to the little variation in this variable over the four years of analysis. It is very collinear to the fixed effect η_i. Once a longer time series of data becomes available, a more precise estimation of this parameter in the fixed effects models will hopefully be possible.

Although they are not used for the calculation of the equivalence scales, a look at the preference shifters is of value: the gender of the household head does not seem to have a significant effect on income satisfaction. The age of the household head has a significant positive effect in the pooled model, this is in line with the literature, where a positive cohort effect is observed. This is reversed in the fixed effects model, where the time-varying age variable possibly takes up the role of the disability variable with which it is correlated.

A significant positive effect of housing tenure can be observed in the pooled ordered probit: tenants and household heads living in mortgaged houses are generally less satisfied with their income than those who own a house outright. This is natural, as those who own their house outright do have lower housing costs in the present than those who do not. Although of policy interest, post-housing cost equivalence scales as those reported by McClement [19] are difficult to calculate with the psychometric method. This variable is not significant in the fixed effects models, as the variation in ownership is too little over the observed period.

Marital status is also important. Household heads which live with their partners without being married, are significantly less satisfied with their income. This might be due to non-optimally pooled resources while the relationship is not formally binding. The divorced and separated are also less satisfied with their income than both married individuals and those who have never been married. This could be explained by the fact that these individuals might be liable to pay for alimony, or simply that the situation they find themselves in has a depressing

[15]The interpretation of signs in the ordered probit model is tricky, see Greene [13], p. 738. Strictly speaking, only the interpretation of the signs for the probability to fall in the first or last category of income satisfaction are unambiguous.

[16]The fact that this variable is not significant in the fixed effects models is owing to the little variation in this variable over the four years of analysis. It is "mopped up" by the fixed effect. Once more years of data become available, a more precise estimation of this parameter in the fixed effects models will be possible.

Table 4: Summary: Simple Specification

Model / **Variable**	**Oprobit, PA** Coefficient		**Oprobit, FE** Coefficient	
$\log\left(y^h\right)$	0.47	***	0.37	***
Needs				
$\log(size)$	-0.40	***	-0.22	***
nodis	-0.17	***	-0.04	
Preferences				
sex	0.04		–	
$\log(age)$	0.15	***	-2.79	**
owned	0.25	***	-0.09	
unemp	-0.43	***	-0.73	***
married	-0.28	***	-0.24	***
gcse	-0.04	*	-0.41	***
period dummies		***		***
No. Obs.		11887		11887
LogLik		-21110		-14293

* denotes significance 10%,** at 5%,*** at1%

effect on (income) satisfaction without really affecting their costs. The widowed are significantly more satisfied with their income than married couples. These findings are robust across the different models. The interpretation of our results show how difficult it is to separate the variables that affect needs from those which affect tastes. Although we can explain the significance of some of these variables by the effect they have on household needs, we reiterate here that we do not use these variables for the calculation of the scales. The adjusted income hence does not reflect the needs for higher housing costs or alimony. As already mentioned, since our main target here is the additional consumption cost of disability, this would only be relevant if housing tenure or marital status was systematically related to disability.

6.1.2 Complex Specification

A summary of the results for the complex specification is presented in table 5. This specification includes the number of children in each age group and the number of adult members of the household, instead of the simple log of the household size. Again, all models exhibit mostly the expected signs; the fixed effects model suffers from the fact that the number of children in each age group changes little in the observed period, and hence not all effects are significant. In the pooled ordered probit children have a significant effect on household costs. The effect of small babies and toddlers (from 0 to 4 year old) seems to be negligible, however: their parameter is not significant. Older children generally cost more, with additional adults having the biggest impact on household cost. This is natural, if we assume that the older the children the more cost they imply in terms of food, schooling, holidays etc.. In the fixed effects models, children from 12 to 15 years imply a significant cost on the household, as do additional adults (both at 10% level)

Disabled members of the household have a significant effect on household cost in the pooled probit model. As we have described, a disabled member in this model counts twice: first as an additional child or adult, and again, as a disabled member of the household. Consequently, if a disabled adult joins the household, the incremental cost is calculated based on the sum of the parameter for her age group and for a disabled person.

The effects of the remaining control variables are very similar to those reported in the simple specification.

6.2 Results for Psychometric Equivalence Scales

For the derivation of the scales, we use only the ordered probit and the fixed effects probit. In table 6 the equivalence scales derived from the simple specification models are reported. Let us first analyse the scales for household size only. Although both scales meet with our expectations in that they exhibit economies of scale in the household, and positive costs of disabled members, the point estimates of the scales differ across models. For example, a two-person household needs 1.8 times the income to be as satisfied with his income as the

Table 5: Summary: Complex Specification

Model	**Oprobit, PA**		**Oprobit, FE**	
Variable	Coefficient		Coefficient	
$\log\left(y^h\right)$	0.52	***	0.35	***
Needs				
no. ch 0-2	−0.02		−0.10	
no. ch 3-4	0.02		−0.10	*
no. ch 5-11	−0.05	***	−0.05	
no. ch 12-15	−0.11	***	−0.09	
no. ch 16-18	−0.13	***	0.01	
no. adults	−0.25	***	−0.06	*
nodis	−0.19	***	−0.05	
Tastes				
$\log(age)$	0.15	***	−2.91	**
owned	0.25	***	−0.09	
unemp	−0.42	***	−0.73	***
married	−0.27	***	0.24	***
gcse	−0.02		−0.41	***
sex	0.02		−	
period				***
dummies		***		***
No. Obs.		11,887		11,887
LogLik		-21,053		-14,293

*** denotes significance at 5% level, ** at 5%, * at 1%

reference household, when using the pooled ordered probit scale, but only 1.52 times the income of a reference household when using the fixed effects probit scale. A three person household would need 2.54 times the reference household's income in the PA scale, and only 1.94 times the reference household's income on the fixed effects probit scale. When taking into account the statistical nature of the scales, however, the fixed effects estimators exhibit larger standard errors, which make it difficult to statistically distinguish the results in the different models.[17]

A similar effect can be observed when taking into account the scales for disability. The scales are very high for the pooled model with a disabled person needing 1.45 times the income of a non-disabled to achieve the same level of income satisfaction. However, in the fixed effects model, a disabled person would need only 1.12 times the amount of a non-disabled person. Obviously, this difference is due to the low disability parameter in the fixed-effects estimations. As the age effect is not taken into account in the calculation of the scale, this most probably does not reflect the true cost of disability to the household.

Table 6: Examples for Equivalence Scales – simple specification

	Oprobit, PA		**Oprobit, FE**	
Household Type	scale	s.e.	scale	s.e.
1 person	1.00	–	1.00	–
1 person, disabled	1.45	0.102	1.12	0.222
2 persons	1.80	0.057	1.52	0.222
3 persons	2.54	0.129	1.94	0.457

Scales based on table (4)

Standard errors calculated with delta method

For the simple scales, hardly any comparative scales exist in the literature. Bellemare et. al. [4] have estimated similar scales for Germany. Bellemare et al. estimate cross-section probit models without taking account of individual effects, so that we have to compare their scales, depicted in table 7, with our estimate for the population averaged probit above. Of course, we can only compare the scales for households without disabled members. Their scales are small compared to our estimates and exhibit lower standard errors. Their scales are not significantly different from our fixed effects scales, but this is due to the high standard error.

Another comparison can be effected with the estimates by Van Praag and Van der Sar [24] for the UK. In this case, we normalise our scales so that a

[17] In fact, the standard errors in the fixed effects models are so large that the scales are hardly significant at all. This is not surprise, given the low significance of the parameters in the model.

Table 7: Comparison: Psychometric Scales for Germany

	Bellemare		**Oprobit, PA**		**Oprobit, FE**	
Household Type	scale	s.e.	scale	s.e.	scale	s.e.
1 person	1.00	–	1.00	–	1.00	–
2 persons	1.34	0.02	1.80	0.057	1.52	0.222
3 persons	1.59	0.04	2.54	0.129	1.94	0.451

Estimations for Germany, based on Bellemare Melenberg, van Soest [4]
Standard errors calculated with the delta method

two-person household has a scale of 1.00. The comparison is presented in table 8. Van Praag's scales are much smaller than in our (simple) models, however his scales seem in any case very low, particularly when comparing them to the official scales by McClement for additional adult. A reason for this might be the log-normal specification of the income satisfaction curve used by Van Praag and Van der Sar.

Table 8: Comparison of results with Van Praag

	Scale of a 2-person household		
household size	Van Praag	Oprobit, PA	Oprobit, FE
1	–	0.55	0.65
2	1.00	1.00	1.00
3	1.12	1.41	1.27
4	1.20	1.81	1.51

Van Praag's scales for the UK based on [24]

Let us now turn to an analysis of the scales derived from the complex specification, presented in table 9. Both scales are reasonable in that they exhibit economies of scale in the household, and disability costs seem not unreasonable. Based on the population averaged probit model, with a single adult as the reference household, a second adult "costs" the household, on average, 0.63 times that of the first. In the fixed effects ordered probit, this reduces to 0.2 times the amount of the first. If a couple is accompanied with a 12 to 15 year old child, the additional cost of the child is about 0.4 times that of an adult, in both models. A family of four with two children needs about 2 to 2.5 times the income of a single adult to be as satisfied with their income.

The scales for disability differ greatly among the models. In line 2 of table 9, we observe that in the ordered probit model, the disability of one adult has an extra consumption cost of 43% of a non disabled individual, or in other words, a disabled individual needs 43% more income than an individual without disabilities to achieve the same income satisfaction. In the fixed effects probit, this amounts only to 14% more.[18] In general, we observe that the higher the standard error of the corresponding coefficient in the panel model, the less significant is the scale.

Table 9: Examples for Equivalence Scales – complex specification

	Oprobit, PA		**Oprobit, FE**	
Household Type	scale	s.e.	scale	s.e.
1 adult	1.00	–	1.00	–
1 adult (disabled)	1.43	0.091	1.14	0.253
2 adults	1.63	0.038	1.20	0.121
2 adults, 1 child 0-2	1.70	0.137	1.61	0.349
2 adults, 1 child 5-11 1 child 12-15	2.26	0.135	1.81	0.609
1 adult, 1 child 12-15	1.25	0.058	1.29	0.227
2 adults;1 ch 12-15	2.04	0.104	1.55	0.356

Source: own calculations based on table 5

We can compare these results with those estimated by McClement [19] (for the UK, before housing costs, available in the BHPS data) and those by Bellemare et al.[19]. Table 10 presents the comparison. Again, as no adjustment for disability has been made in the scales by Bellemare and McClement, we can only compare the results for households without disabled members.

As in the simple specification, our scales are higher than Bellemare's; as their scales are for Germany with a more extensive benefit system both for children and the elderly, this is not surprising. What is surprising is the difference in standard errors of both scales. This might be due to better quality of the data in the GSOEP or the different estimation technique used by Bellemare and van Soest.[20] We can now compare our scales with the official scales used in the UK, the McClement scales. Although the two scales are based on different methods, (consumption-based versus psychometric analysis), their point estimates coincide for the pooled probit, and are statistically very similar to the fixed effects ordered probit model scales.

Finally, we compare our results for disability costs (simple scales) with those of Jones and O'Donnell and Zaidi and Burchardt. These authors have estimated

[18] Again, this low number is due to the low parameter value in the fixed effects probit model.
[19] For the latter, the caveat applies again that the estimates are for Germany.
[20] They used a variety of nonparametric estimators with bootstrapped standard errors.

Table 10: Comparison with McClement Scales

Household Type	**Bellemare** scale	s.e.	**McClement** scale	**Oprobit, PA** scale	s.e.	**Oprobit, FE** scale	s.e.
1 Adult	1.00	–	1.00	1.00	–	1.00	–
2 Adults	1.30	0.02	1.63	1.63	0.038	1.20	0.121
2 Adults, 1 ch 0-2	1.34	0.03	1.78	1.70	0.137	1.61	0.349
2 Adults, 1 ch 5-11, 1 ch 12-15	–	–	2.41	2.26	0.135	1.81	0.609
1 adult, 1 ch 12-15	1.17	0.03	1.44	1.25	0.058	1.29	0.227
2 adults, 1 ch 12-15	1.52	0.04	2.07	2.04	0.104	1.55	0.357

Source: Table 9, Bellemare ([4]) McClement ([19])

log scales for disabilities, which are presented, together with our corresponding estimates, in table 11.[21] Jones and O'Donnell's estimates are based on the estimation of food share and alcohol equations with non-linear income effects. In both equations, the disability variable is hardly significant in their estimations, and the log scales are badly determined. The point estimates of the log scales they report for fuel and transport services are of a similar size, but also not very precise, none of their scales is significantly different from zero. Our point estimate in the pooled model is the same as in their equation based on alcohol, while the point estimate of the fixed effect model is similar to their food equation scale.

Zaidi and Burchardt's estimates are based on standard of living - income curves in the BHPS and family resource surveys, and derived from a regression for a single adult household. Our estimates in the pooled model is slightly lower than in both their estimations.

We conclude for now, that we can identify economies of scale in the household, and positive consumption cost of disability. In the remainder of this paper, we will analyse the effect of these scales on inequality and poverty analysis.

[21] The log scales for disability correspond in our models to the negative of the ratio between the parameter that accompanies the number of disabled people in the household and the parameter for log household income (simple model). They can be interpreted as the additional percentage of income necessary to compensate the consumption cost of a disability. For the calculation of logscales in Jones and O'Donnell, see their paper [14], p. 279.

Table 11: Comparison with Other Disability Scales

Log Scale	Jones - O'Donnell	Zaidi - Burchardt	This Paper
Food	0.14		
Alcohol	0.34		
FRS/^{a}		0.51***	
BHPS/^{b}		0.43***	
Oprobit, PA			0.36***
Oprobit, FE			0.11

/^{a} Table 5 [30], first column, for mid-severity level

/^{b} Table 7 [30], second column, *** indicates significance at 1% level

6.3 Impact of Disability on Poverty

In this section, we will use the point estimates of the equivalence scales in the previous section to illustrate the impact of adjustment for disability on poverty measures in the UK.[22] For these purposes, we examine two poverty lines, namely 40% and 60% of median income respectively. We calculate the median income separately for each year, so that the analysis is performed in terms of relative poverty. Moreover, we concentrate on the simple scales, as the scales for disability do not significantly differ in the two specifications. The poverty rates are calculated on an individual basis, i.e. the percentages shown in the tables below are percentages of the population in poverty, not of households in poverty.

In the first step, we ignore the presence of additional consumption costs of disability to warrant comparability. Table 12 compares the poverty rates for the pooled and fixed scale with the official McClements scales; Despite slight differences in the scales, the poverty rates are very similar in all three distributions, and are also quite stable across the years. 5-6% of the population live in households with income below 40% of the median income, while about 16-18% live in households with income below 60% of median income.[23] However, the point estimates allow to conclude that a very slight decrease in relative poverty has taken place from 1996 to 1999. In what follows, we will concentrate only on comparison of the scales in1996 and 1999.

In table 13 we compare overall poverty rates when adjusting for disability

[22]Given the high standard errors in the scales, particularly in the fixed effects model, the results are of illustrative nature. As the standard errors are extremely high for family sizes larger than 5, we focus the analysis on family sizes up to 5 members, and up to one disabled member.

[23]Note that these numbers are likely to be biased towards less poverty than in a representative sample, as large families (more than five members) and families with more than one disabled individual are excluded from the analysis).

Table 12: Comparison of Scales: Effect on Overall Poverty Rates

Year	Poverty Line	Poverty Rate in %		
		Oprobit, PA	Oprobit, FE	McClement
1996	40% of median inc.	6.12	5.70	4.70
	60% of median inc.	16.52	17.82	17.70
1997	40% of median inc.	6.18	7.02	5.89
	60% of median inc.	17.37	18.40	17.76
1998	40% of median inc.	5.73	6.16	5.70
	60% of median inc.	16.31	18.26	16.64
1999	40% of median inc.	4.76	5.01	4.63
	60% of median inc.	15.27	16.87	16.06

Calculations based on table 6, without adjusting for disability costs

with those where disability is not taken into account. As expected, in both models we observe higher poverty levels when adjusting for disability for either poverty line. This reflects the fact that the income of households with disabled members is lower when it is adjusted for disability costs.

Table 13: Poverty Rates, scales with and without adjustment

Year	Poverty Line	Poverty Rate in %			
		without adjustment		with adjustment	
		Oprobit, PA	Oprobit, FE	Oprobit, PA	Oprobit, FE
1996	40% of med. inc.	6.12	5.70	7.20	5.93
	60% of med. inc.	16.52	17.82	18.44	18.72
1999	40% of med. inc.	4.76	5.01	5.48	5.16
	60% of med. inc.	15.27	16.87	17.68	17.50

Calculations based on table 6

In table 14 we present the same poverty rates, however, we focus on the population living in households with disabled individuals. The poverty rates are calculated as percentage of the population in families with disabled members. Comparing the first two columns of table 14 with table 12, we observe that the poverty rates at the 40% of median level are lower, while the poverty rates at the 60 % level are higher for individuals living in families with disabled members. Extreme poverty, if measured with traditional scales, is therefore lower among these families than their fellows without disabilities, possibly because of generous benefit levels. The fact that individuals living in families with disabled members are not generally better off is proved by the rates at the 60% level, which are significantly higher than those for the overall population. This is also the case for the official UK scales, reported in the fifth column of table 14.

Two striking observations can be made in this table: firstly, the huge reduction of poverty of the families with disabled members during the four years under analysis, and secondly, the high rates of poverty when adjusting for the costs of disability. Poverty (at the 60% line) among the disabled is reduced by more than one third from 1996 to 1999 when adjusting income by our scales, but also when using the McClement scales. The rate adjusts to the overall poverty rate of the population; this cannot be an outcome of the disability benefits reform, which took effect only after 2000 (see Buchardt [7]); average benefit levels for the disabled did increase, however, by about 25% from 1996 to 1999, while average income levels for the entire population did not experience this increase. On the other hand, extreme poverty among the disabled slightly rose during this time, similarly aligning itself with the rate of the overall population.

When comparing the rates for the disabled with adjustment for costs of disability (in column three and four) with the unadjusted ones, we observe large differences. For 1996, the poverty rate at the 40% level is more than five times higher with adjustment, and the rate doubles at the 60% level, so that nearly half of the population living in households with disabled members lives below this poverty line. Even in the fixed effects model, which implied a comparatively low cost for disability, the rate is nearly double the unadjusted rate.

Table 14: Poverty among families with disability, with and without adjustment

		Poverty Rate in %				
		without adjustment		with adjustment		
Year	Poverty Line	PA	FE	PA	FE	McClements
1996	40% of med. inc.	3.90	3.25	20.17	6.72	2.81
	60% of med. inc.	22.55	25.81	51.41	39.26	27.76
1999	40% of med. inc.	4.21	4.57	13.18	6.41	4.39
	60% of med. inc.	14.28	16.66	44.32	24.54	16.30

7 Conclusions

In this paper, we have explored the possibility to use equivalence scales to identify a welfare measure that meets with Sen's requirements of reflecting an individual's personal, social and environmental restrictions in decision making. We have shown under which assumptions a Senian capability set can be reinterpreted as a consumption opportunity set, and have estimated this set taking into account the special constraints faced by families with disabled members.

This capability measure is significantly different from the traditional income measure, and also different from a subjective welfare measure such as utility; yet it uses the income metric to capture and measure the reduction in capability of a disabled individual. While the estimation took place on the household level, our method does allow to assess capability at the individual level by focussing on single adult households; we show that a disabled individual has a consumption opportunity set which is reduced by 43% compared to a non disabled individual. In this context, it is important to reiterate that this reduction occurs despite the fact that many disabled individuals already receive compensation benefits and other allowances to help them with the additional cost. Taking this difference in consumption opportunities into account in, say, poverty analysis leads to a significant change in the poverty rates. This leads to two policy conclusions: firstly, the benefit levels for disabled should possibly be scrutinised, as their level does not seem high enough to compensate for the entire additional consumption cost implied by the disability. Secondly, alongside traditional measures of poverty or welfare distribution, it would be interesting and advisable to present measures adjusted for disability as well, to reflect a more exact picture of social welfare.

We consider our estimations to be a first step towards the measurement of the capability set of the disabled. Further analysis would include a refinement of the disability variable, e.g. according to degree of disability, as available in the GSOEP. This, combined with a longer time series would possibly lead to a higher precision of the scales, particularly in the fixed effects model.

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