Disability Status and Older People's Receipt of Disability Benefit in British population surveys: A Latent Variable Structural Equation Approach

Marcello Morciano*º, Francesca Zantomio*+, Ruth Hancock º and Steve Pudney*

**Institute for Social and Economic Research, University of Essex*

ºHealth Economics Group, University of East Anglia

+ Research Institute for the Evaluation of Public Policies

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ABSTRACT: Targeting efficiency of disability-related social security benefits in the UK is under debate: it has been argued that a substantial proportion of those who receive Attendance Allowance (AA), the main disability benefit available to older people, are not disabled and/or have relatively high incomes. We compare the pattern of receipt of AA in three data sources: the British Household Panel Survey, the English Longitudinal Study of Ageing and the Family Resources Survey. We develop and estimate via robust maximum likelihood a structural equation model in which probabilities of receiving AA depend on a latent disability status indicator – measured by survey-specific self-reported functional limitations indicators – and a set of observable socio-economic characteristics. Results indicate that the probability of being in receipt of AA is clearly disability-related and negatively associated with economic resources. While the comparison of the conditional distribution of AA among surveys might be biased by survey features affecting each sample composition, once this is controlled for through statistical matching, the three surveys still deliver similar results in term of the disability and socio-economic gradient in AA receipt.

Keywords: disability indexes, disability benefits, multiple surveys.

JEL codes: C81, I18, I38

Address for correspondence: Marcello Morciano, Health Economics Group, School of Medicine, Health Policy & Practice, University of East Anglia, NR4 7TJ Norwich, UK (*m.morciano@uea.ac.uk*)

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1. Introduction

Many different disability indicators have been developed and used in surveys (Jagger et al, 2009), raising the question of which set is best able to capture the underlying disability status. It has been recognised that any particular set of disability related indicators might offer an inadequate description of the specific form of disability relevant to the analysis (Bound, 1991). When used in policy analysis, the choice of indicator could influence the conclusions drawn with important implications for those affected by the policy. In this paper we investigate whether, for older people, different indicators of disability collected in three widely-used household surveys produce similar estimates of underlying disability in the context of the targeting of disability benefits for older people. Analysis by Forder and Fernandez (2009) – underpinning the recent social care Green Paper (DH, 2009) – suggests that a "relatively large number of people, despite having no limitations in activities of daily living, receive Attendance Allowance (AA) (p. 12)". The robustness of this finding is central to current debates over the role of disability benefits for older people in the care and support system.

AA, the main disability cash benefit available to people aged 65 or over in UK, is meant to help meet the extra costs arising from disability. Besides the age condition, eligibility for AA requires the claimant to need care in order to perform daily activities such as washing, eating, dressing, using the toilet, communicating needs; or supervision to avoid the risk of danger to self or others. The benefit is not means tested and awards either £47.10 per week, if care is needed throughout either day or night, or £70.35 per week, if care is needed throughout both night and day.

Eligibility for AA is not straightforward to assess from survey data. In practice, eligibility is assessed by programme administrators on the basis of claimants' reported health problems and consequent care needs[1]. An element of judgement is inevitable, implying that eligibility is uncertain to the researcher - even if observing the same information set as the administrative assessor. A further challenge is that the information on which the award decision is made is not observable directly in survey data. Rather, survey data offer a set of disability-related eligibility indicators, from which inference on the success of disability targeting must be drawn.

Typically, the econometric analysis of disability benefit receipt employs a single-equation framework, in which a variety of indicators (or a count index of them) are used as explanatory covariates, with other observable socio-economic status (SES) characteristics (Forder and

[1] The claim form for AA is available on line at < http://www.dwp.gov.uk/advisers/claimforms/aa1a_print.pdf>. Once the claim is made, written evidence is examined by administrative assessors, who can require a medical examination of the claimant.

Fernandez, 2009). In this paper we estimate a system of equations, using a structural equation technique (Bollen, 1989), to study the relationships between disability status, SES characteristics, and receipt of AA in three surveys: the British Household Panel Survey (BHPS), the English Longitudinal Study of Ageing (ELSA) and the Family Resources Surveys (FRS) – compared at a single point in time, 2002/03. While acknowledging that an individual's disability status is not directly observable (i.e. latent), we assume it can be measured by a vector of observable indicators, which are caused by the latent disability and may be measured with error. The latent disability is influenced by a set of SES characteristics. The probability of receiving AA is modelled as a function of the latent disability indicator and the set of SES characteristics which are also allowed to have a direct effect on latent disability. All the equations are jointly estimated via robust maximum likelihood.

This methodological approach has several advantages. First, overcoming the arbitrariness of approaches based on a limited set of disability indicators or a scalar (un)weighted "count" of them, the latent variable framework allows us to derive an index of disability exploiting the sample covariance matrix of the full list of disability-related indicators. Second, the latent variable framework reduces the scope for bias stemming from measurement error in observed disability-related indicators. Third, the estimation of a system of equations – as opposed to a single equation – allows us to identify the relationship between a set of SES characteristics – irrelevant to AA eligibility- and the probability of AA receipt, having controlled for the correlation between those characteristics and the underlying disability status. Being able to judge whether a set of socio-demographic characteristics - irrelevant to AA eligibility – influences directly the probability of receiving AA (e.g. through claim behaviour) is essential to the assessment of the benefit target efficiency: perfect targeting would imply no scope for such characteristics to confound the benefit assignment mechanism, although they might be correlated with the disability status on which the eligibility assessment is based.

Because part of any cross-survey difference or similarity observed in the conditional or unconditional distribution of AA receipt might result from survey features affecting the distribution of conditioning covariates in each survey sample, we use propensity score matching techniques to obtain samples sharing the same distribution of SES conditioning covariates and repeat estimation on each set of matched samples.

By comparing results obtained from three different survey data sources, we aim at contributing to the disability measurement debate by testing whether, despite the differences in the number and type of indicators available from alternative surveys, a latent variable approach allows us to extract the relevant information from the available set of pertinent indicators, in such a way that the same structure of behaviour (receipt of a disability benefit, in our case) can be retrieved from different data sources.

The remainder of the paper is organised as follows: next section describes the methodological framework. Section 3 presents a brief introduction to each survey and the variables used and shows sample descriptive statistics. Results from the reduced form estimation on the three unmatched samples are discussed in Section 4, while the matching procedure and post matching results are described in Section 5. A final section draws conclusions.

2. A model of disability status and disability benefit receipt.

In line with much of the research literature[2], we model the 'true' disability status as an unobservable, possibly multidimensional, phenomenon, which is influenced by a set of socio-economic characteristics and which can be measured imperfectly by a set of observable disability-related indicators. Any of these indicators can be considered as a partial measure of the underlying disability status and we assume any correlation between them and other socio-economic characteristics to be explained by the latent disability. The main outcome of interest, receipt of AA, depends on latent disability and the set of socioeconomic characteristics.

To clarify the statistical framework, we define the following notation: we observe independent samples of individuals in a set of S different surveys, indexed by $s = 1 \ldots S$. Each sampled individual i is characterised by unobserved levels of Q dimensions of 'true' disability $\eta_{i1} \ldots \eta_{iQ}$, a vector of socio-economic individual characteristics $\mathbf{Z}_i$ which is observable in all of the surveys, a set of survey-specific disability related discrete indicators D_{ij}^s, $j=1 \ldots K_s$ and a binary indicator $R_i \in \{0, 1\}$ of benefit receipt. We aim at drawing inferences about the joint distribution $P(R, \mathbf{D}^1 \ldots \mathbf{D}^S, \boldsymbol{\eta} \mid \mathbf{Z})$ where $\mathbf{D}^s$ is the K_s-dimensional vector with elements D_{ij}^s and $\boldsymbol{\eta}$ is the vector of true disabilities. We are specifically concerned with the conditional benefit receipt probability $P(R \mid \mathbf{Z}, \boldsymbol{\eta})$ and the conditional distribution of disability, $P(\eta \mid Z)$. An important question is whether the S different surveys with their different disability indicators nevertheless give a coherent indication of underlying 'true' disability. We adopt a parametric latent variable structure for the indicators j used in survey s:

$$\widetilde{D}_{ij}^s = \alpha_j^s + \lambda_{j1}^s \eta_{i1} + \ldots + \lambda_{jQ}^s \eta_{iQ} + \varepsilon_{ij}^s \tag{1}$$

The coefficients λ_{jq}^s are the factor loadings which relate observed indicators to underlying disability status and ε is the residual term which might represent some form of measurement error.

[2] Wolfe and van der Gaag (1981) is one of the first studies where a latent variable technique is used to measure health status.

We make the usual assumption that the random error ε_j has expected values of zero and is uncorrelated with η_{iq}.

A further observational difficulty is that the indicators $\widetilde{D}_{ij}^{s}$ are not observed fully, but only in ordinal form. We use standard ordered or binary probit link functions to generate the observable ordinal indicators D_{ij}^{s} from the unobserved continuous variable $\widetilde{D}_{ij}^{s}$:

$$D_{ij}^{s} = m \qquad \text{iff} \quad A_{j,m-1}^{s} \leq \widetilde{D}_{ij}^{s} < A_{j,m}^{s}\ , \qquad r = 1 \ldots M_{j}^{s} \tag{2}$$

where M_{j}^{s} is the number of response categories for indicator D_{ij}^{s} and the $A_{j,r}^{s}$ are threshold parameters.

We assume that the true disability levels η_{iq} are related to $\mathbf{Z}_j$ through a linear regression:

$$\eta_{iq} = \theta_q Z_i + \upsilon_{iq}\ , \qquad j = 1 \ldots \mathrm{J};\ \ i = 1 \ldots n_j \tag{3}$$

where θ_q is a vector of coefficients associated and υ_{iq} represents other factors not included in Z_i which are likely to affect η_{iq} under the assumption that $\mathrm{E}(\upsilon_{iq}) = 0$ and $\mathrm{Cov}(\mathrm{Z}_i,\ \upsilon_{iq}) = 0$.

Benefit receipt is modelled adopting a logit specification:

$$\widetilde{R}_i = \beta Z_i + \gamma_1 \eta_{i1} + \ldots + \gamma_Q \eta_{iQ} + u_i \tag{4}$$

where the benefit receipt indicator R_i is equal to 1 when $\widetilde{R}_i > 0$ and 0 otherwise. β and γ_q are coefficient and u_i is a stochastic disturbance term.

For full identification, we assume that $\left(\varepsilon_{i1}^{s} \ldots \varepsilon_{i1}^{s}, u_i\right)$ are mutually independent and independent of $\left(\upsilon_{i1} \ldots \upsilon_{iQ}\right)$, which may be inter-correlated. However, the coefficients $\lambda_{j1}^{s} \ldots \lambda_{jQ}^{s}, \theta_1 \ldots \theta_Q$, the covariance matrix of $\left(\upsilon_{i1} \ldots \upsilon_{iQ}\right)$ and the variances of $\left(\varepsilon_{i1}^{s} \ldots \varepsilon_{i1}^{s}\right)$ are identified in the more general setting where we allow for correlation between u_i and $\left(\upsilon_{i1} \ldots \upsilon_{iQ}\right)$. The remaining parameters are identified[3] if we have at least Q exclusion restrictions on the coefficient vector β.

Equations (1) and (4), which specify how the observable indicators are related to the latent variables, is usually referred to as the 'measurement model' (Bollen, 1989); the model (3) of true disability status is generally referred to as the 'structural equation' or 'causal model', emphasizing its causal role in the determination of disability.

3. Data and variables definition

The empirical analysis is based on $S = 3$ survey samples corresponding to the first wave of ELSA, the twelfth wave of BHPS and the 2002/03 cross section of FRS. The FRS constitutes the

[3] A full treatment of the identification problem can be obtained upon request from the authors.

basis for most official statistics on welfare and disability programs targeting (Kasparova et al., 2007) and has been widely used for the analysis of benefit participation (Hancock et al., 2005). It collects very detailed income and benefits receipt information. It offers a large sample size of more than 25,000 non-institutionalized households. ELSA data offer a considerable representation of adults aged 50 and over in England (about 8,000 households) and a richer set of self-reported health status and disability measures. BHPS has a smaller sample but provides a third source of survey data on disability and AA receipt. A detailed description of survey specific aspects such as sample design, data collection, adjustment procedures, weighting etc. can be found in Taylor et al. (2006) for BHPS; in Campbell (2004) for FRS; and Taylor et al. (2003) for the ELSA wave 1.

We limit the analysis to people aged 65 years or over, living in England. The latter restriction is imposed by the ELSA sampling frame. We drop cases where relevant information is missing. This includes proxy respondents in ELSA (1.9%) and BHPS (4.06%) since their proxy questionnaires do not collect information essential to our analysis. In all the three surveys, we exclude cases of individuals in receipt of Disability Living Allowance (a similar benefit that can be claimed before age 65) because DLA recipients generally continue to receive DLA after 65 years old, opting out of the possibility of claiming AA. The three resulting samples consist of $N_{BHPS} = 1{,}042$ individuals observed in the BHPS, $N_{ELSA} = 5{,}152$ individuals observed in ELSA and $N_{FRS} = 7{,}327$ individuals observed in FRS.

Disability-related indicators available in the three surveys (although not necessarily in each one of them) include self assessed health or disability status, health-related limitations to or difficulties in performing (instrumental) activities of daily living, self-reported presence of particular medical conditions, use of health care or disability aids, receipt of formal and informal care, administrative registration as a disabled person and objective measures, obtained through external assessment. Because AA eligibility relates to the need for care in order to perform daily activities, it is the group of functional limitations indicators, e.g. health-related limitations to or difficulties in performing (instrumental) activities of daily living, that we use to measure the true disability status η_j, relevant to AA eligibility assessment. In the geriatric literature, Johnson and Wolinsky (1993) provide a general conceptualization of the dynamics of health status among older population where functional limitations are considered to *be caused* by the latent disability, supporting the assumptions made with respect to equation 1. The list of functional limitations

Table 1: Survey specific functional limitations indicators D (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$)

		not receiving AA		receiving AA		diff
Data Source:		mean	sd	mean	sd	
FRS: *Has difficulty with:*						
DISDIF1	mobility (moving about)	0.25	0.43	0.82	0.39	-0.567***
DISDIF2	lifting, carrying or moving objects	0.22	0.41	0.73	0.44	-0.515***
DISDIF3	manual dexterity using hands to carry out everyday tasks	0.08	0.27	0.40	0.49	-0.321***
DISDIF4	with continence (bladder control)	0.05	0.22	0.23	0.42	-0.180***
DISDIF5	communication (speech, hearing or eyesight)	0.04	0.19	0.20	0.40	-0.158***
DISDIF6	memory/concentration/learning/understanding	0.05	0.22	0.25	0.44	-0.204***
DISDIF7	recognising when in physical danger	0.01	0.07	0.06	0.25	-0.0595***
DISDIF8	your physical co-ordination (eg balance)	0.04	0.19	0.09	0.29	-0.0507***
	Observations	*6602*		*725*		
ELSA: *Has difficulty with:*						
WALK	walking 100 yards	0.12	0.32	0.57	0.50	-0.453***
SIT	sitting for about two hours	0.13	0.33	0.28	0.45	-0.153***
CGHAIR	getting up from a chair after sitting for long periods	0.28	0.45	0.62	0.49	-0.338***
CLIMB1	climbing several flights of stairs without resting	0.42	0.49	0.81	0.39	-0.390***
CLIMB2	climbing one flight of stairs without resting	0.16	0.37	0.65	0.48	-0.486***
STOOP	stooping, kneeling, or crouching	0.41	0.49	0.79	0.41	-0.377***
ARMS	reaching or extending your arms above shoulder level	0.10	0.30	0.34	0.47	-0.238***
PULL	pulling or pushing large objects like a living room chair	0.18	0.39	0.67	0.47	-0.488***
LIFT	lifting or carrying weights over 10 pounds, like a heavy bag	0.28	0.45	0.79	0.41	-0.512***
COIN	picking up a 5p coin from a table	0.05	0.22	0.24	0.43	-0.190***
ADRESS	dressing, including putting on shoes and socks	0.13	0.33	0.47	0.50	-0.338***
AWALK	walking across room	0.03	0.16	0.20	0.40	-0.176***
ABATH	bathing or showering	0.13	0.33	0.57	0.50	-0.441***
AEAT	eating, such as cutting up your food	0.01	0.11	0.09	0.29	-0.0791***
ABED	getting in or out of bed	0.04	0.21	0.28	0.45	-0.240***
ATOILET	using the toilet, including getting up or down	0.03	0.17	0.18	0.38	-0.151***
IMAP	using a map to figure out how to get around in a strange place	0.06	0.23	0.22	0.42	-0.163***
IMEAL	preparing a hot meal	0.03	0.17	0.28	0.45	-0.250***
ISHOP	shopping for groceries	0.08	0.28	0.50	0.50	-0.417***
IPHONE	making telephone calls	0.02	0.14	0.09	0.29	-0.0744***
IMEDIC	taking medications	0.01	0.10	0.08	0.28	-0.0729***
IWORK	doing work around the house or garden	0.16	0.37	0.65	0.48	-0.491***
IMONEY	managing money, such as paying bills and keeping track of ex	0.02	0.15	0.15	0.36	-0.130***
	Observations	*4780*		*372*		
BHPS: *Health hinders:*						
AHSWK	doing the housework	0.09	0.28	0.57	0.50	-0.484***
ASTAIRS	climbing the stairs	0.11	0.31	0.60	0.49	-0.495***
ADRESS	getting dressed	0.04	0.19	0.17	0.38	-0.137**
AWLK	walking more than 10 mins	0.09	0.29	0.52	0.50	-0.426***
	How manages ..(6 points scale)					
A1STAIRS	stairs	1.86	1.13	3.92	1.57	-2.064***
A1AROUND	getting around house	1.35	0.74	2.61	1.34	-1.264***
1BED	getting in/out bed	1.36	0.72	2.55	1.23	-1.187***
A1NAIL	cutting toenails	2.56	1.79	4.92	1.33	-2.365***
A1BATH	bathing/showering	1.57	1.00	3.28	1.56	-1.708***
A1ROAD	walking down road	1.68	1.16	3.77	1.73	-2.095***
	Observations	*967*		*75*		

indicators D_j offered by each survey and used in our analysis is reported in Table 1, together with their prevalence among AA recipients and non recipients. The eight FRS binary indicators cover broad difficulties in areas of life, while the ELSA provides a longer list of indicators including limitations to specific Activities of Daily Living (ADL) (Katz *et al*, 1963) or Instrumental Activity of Daily Living (IADLs) (Lawton and Brody, 1969). The BHPS indicators include binary indicators for activities limited by health; and a set of six-points scale indicators of difficulty, built from two questions collecting information on whether the respondent usually manages to perform a set of mobility and personal care activities only with assistance or by self, and if whether he/she finds it very easy, fairly easy, fairly difficult or very difficult. Unweighted sample means reveal a statistically higher prevalence of reported functional limitations among AA recipients than non recipients, consistently across surveys and survey specific indicators.

The set of other personal characteristics **Z** includes age, gender, terminal education age, housing tenure, partnership, cohabitation with household members other than the partner, and the logarithm of per capita pre-benefit income[4]. The variables have been derived in a comparable manner between surveys, as far as allowed by the source data, although, in a few cases, a perfect overlap of survey specific measures cannot be guaranteed (given for example, in the case of income, the higher level of detail and consistency in collecting income information offered by FRS as opposed to BHPS or ELSA)[5]. Descriptive statistics for the socio- economic characteristics **Z** observed in each sample are reported in Table 2.

While the sample distribution of some SES variables appears remarkably similar in the three samples, also a few significant differences emerge: for example, ELSA sample members appear to be significantly younger and more educated than their BHPS and FRS counterparts; the proportion of home-owners is higher in the two panel surveys samples than in the FRS; and the BHPS (log) income sample mean is significantly higher than in the other two samples.

In each survey, information about receipt of AA, R_i, is collected through individual questions following those on health and disability. Question ordering may influence response (Crossley and Kennedy 2002) since some respondents appear to use a strategy aimed at justifying a previously mentioned benefit receipt, giving rise to an upward *justification* bias in the reported degree of disability. There are some differences between the surveys in the reference period for AA receipt: the BHPS question covers the 12 preceding the interview; the FRS question refers specifically to

[4] Income is derived as the sum of income from pensions, earnings, saving and other sources, excluding disability and means tested benefits, received by all the members of the benefit unit. Means tested benefits are excluded as their level depends on receipt of AA through the Severe Disability Premium. To account for benefit unit size we divide income by the number of benefit unit members.

[5] For example, ELSA collects some income sources gross of tax and others net. From BHPS it is not always possible to distinguish whether a particular income source is collected gross or net.

the time of interview; and ELSA uses separate questions about different points in time (the time of interview, a year before the interview and the month of first receipt if payment began in between). For ELSA we use receipt of AA at the time of interview. The unweighted sample proportion of AA recipients are 9.9% for FRS and 7.2% for ELSA and BHPS. Use of survey weights gives a small increase in AA prevalence in ELSA (7.8%) and BHPS (7.9%) and a very small reduction in FRS (9.7%), but leaves the comparison substantially unaltered.

Table 2: Sample means of SES and AA receipt in FRS, ELSA and BHPS

	FRS		ELSA		BHPS	
	mean	sd	mean	sd	mean	sd
Female	0.559	0.497	0.557	0.497	0.560	0.497
age of adult last birthday	74.567	6.729	74.164	6.644	74.698	6.437
educated beyond compulsory schooling	0.508	0.500	0.527	0.499	0.513	0.500
log of pre-benefit per-capita income	6.268	0.784	6.249	0.738	6.392	0.713
whether home owner	0.724	0.447	0.766	0.423	0.768	0.422
whether partner de facto lives in hh	0.577	0.494	0.565	0.496	0.553	0.497
whether somebody other than single/couple in hh	0.111	0.314	0.121	0.326	0.122	0.327
receiving AA	0.099	0.299	0.072	0.259	0.072	0.259
Observations	7,327		5,152		1,042	

Note: Based on unweighted selected samples (see above for a description of the selection rules applied).

Such proportions can be compared with administrative data on AA recipients. However, administrative statistics include people in institutions, who are not covered by the surveys and are more likely to be eligible for AA. Official statistics on the number and percentage of AA recipients in institutions are not currently available. Drawing on estimates of the care home population in England and the proportion of them who receive no financial support from their local authority[6] (and so could receive AA or DLA) we can place bounds on the numbers of AA and DLA recipients who are living in care homes. The resulting estimate for the percentage of AA recipients relevant for our comparison (non-institutionalized people aged 65+ in England not in receipt of DLA) is in the range 12.7-13.8%. A possible explanation for the surveys' underestimation of AA receipt is the difficulty of contacting disabled people and collecting information from them through population surveys. In addition to health-related initial non response, longitudinal surveys like ELSA and BHPS might suffer from further health-related attrition. This view is supported by an analysis of proxy respondents in the FRS, revealing AA receipt to be about twice as high among proxy respondents as non proxy respondents (16.5% against 9.48%). In fact the FRS sample - where we can analyse proxy respondents because the necessary variables were collected for them - shows AA prevalence closer to the administrative figure.

[6] Work in progress as part of the MAP2030 research programme. See http://www.lse.ac.uk/collections/MAP2030/

4. Estimation Results

Separate sets of estimates were obtained for the FRS, the ELSA and the BHPS datasets using the model comprising equations (1) (3) and (4) with a single latent disability (Q = 1). The results are reported in Tables 3 and 4 and display a good sample fit in each case.[7] Table 3 shows results for the measurement equations (1) which relate the observed functional limitation indicators to latent disability status. Under each survey heading, the three columns report the estimated factor loadings λ^s_{jq}, their standard errors and the squared correlation of each indicator D^s_{ij} with the latent disability construct η.

Not surprisingly, the factor loadings, representing the effect of latent disability η on each indicator D^s_{ij}, are all positive and highly significant in each survey. Some indicators display substantially higher correlations with latent disability than others: in FRS, the highest squared correlation is found for indicators of difficulties with movements (lifting, carrying or moving objects, moving about, manual dexterity using hands to carry out tasks) whereas lower correlations are found for indicators of physical co-ordination problems and difficulties closely tied to cognitive functions (i.e. difficulties in communication). Interestingly, the most highly correlated indicators in ELSA describe, with a slightly different order, the same type of movement difficulties (walking, pulling or pushing large object, lifting heavy objects, climbing stairs), while lower correlations are again found for indicators associated with mental functioning (i.e. managing money and paying bills, taking medications and making telephone calls). In BHPS, the highest squared correlation indicators are those measuring difficulties in getting around the house, walking down the road and climbing stairs. For the BHPS indicators measured on a 6 points scale, observed squared correlations are generally higher (0.86-0.84) than those obtained for equivalent ELSA and FRS indicators. Despite the differences among functional limitation indicators collected in the three surveys, it is impressive to see how similar is the picture they convey.

Health status, disability prevalence and the severity of disability are well known to vary according to SES (see for example Goldman (2001) for a review of the literature on health inequality). We describe the heterogeneity in the conditional mean of latent disability using a set of socioeconomic characteristics comparable across surveys.

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[7] Stand alone index of fit like the Root Mean Square Error of Approximation (RMSEA) is not currently available in Mplus (Muthén and Muthén, 2007) when a robust ML estimator is used. Using weighted least squares estimator we found a very good fit in FRS and ELSA (p <0.05) and a moderate fit in BHPS (p <0.10).

Table 3: Factor loading (λ^{s}_{jq}), standard error and squared correlation of functional limitation indicators with disability index (*η*)

	FRS			ELSA			BHPS		
	Stdzd coefficient	S.E.	Squared Correlation with disability index	Stdzd coefficient	S.E.	Squared Correlation with disability index	Stdzd coefficient	S.E.	Squared Correlation with disability index
DISDIF1	3.103 ***	0.15	0.729						
DISDIF2	3.309 ***	0.18	0.874						
DISDIF3	2.143 ***	0.09	0.641						
DISDIF4	1.319 ***	0.07	0.372						
DISDIF5	1.246 ***	0.07	0.335						
DISDIF6	1.369 ***	0.07	0.376						
DISDIF7	1.805 ***	0.16	0.505						
DISDIF8	0.298 ***	0.06	0.02						
WALK				2.299 ***	0.09	0.666			
SIT				0.966 ***	0.05	0.268			
CGHAIR				1.342 ***	0.05	0.415			
CLIMB1				1.89 ***	0.08	0.579			
CLIMB2				2.244 ***	0.08	0.654			
STOOP				1.727 ***	0.07	0.541			
ARMS				1.254 ***	0.05	0.375			
PULL				2.269 ***	0.09	0.659			
LIFT				2.289 ***	0.09	0.653			
COIN				1.132 ***	0.06	0.321			
ADRESS				1.457 ***	0.06	0.455			
AWALK				2.461 ***	0.15	0.694			
ABATH				1.844 ***	0.07	0.557			
AEAT				1.418 ***	0.11	0.429			
ABED				1.818 ***	0.09	0.558			
ATOILET				1.626 ***	0.09	0.5			
ISHOP				0.171 ***	0.01	0.351			
IWORK				0.235 ***	0.01	0.43			
IMAP				1.001 ***	0.05	0.263			
IMEAL				2.065 ***	0.12	0.604			
IPHONE				0.964 ***	0.08	0.252			
IMEDIC				1.406 ***	0.12	0.421			
IMONEY				1.291 ***	0.08	0.375			
AHSWK							3.05 ***	0.36	0.785
ASTAIRS							3.601 ***	0.46	0.839
ADRESS							2.5 ***	0.34	0.717
AWLK							3.23 ***	0.36	0.809
A1STAIRS							3.288 ***	0.2	0.811
A1AROUND							3.88 ***	0.31	0.86
A1BED							3.627 ***	0.29	0.839
A1NAIL							1.856 ***	0.1	0.566
A1BATH							2.908 ***	0.18	0.767
A1ROAD							3.863 ***	0.27	0.851

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Estimates for the 'structural model' (eq. 3), describing the effect of SES characteristics on the individual's latent disability status are reported in the top panel of Table 4, displaying under each surveys heading estimates of coefficients θ and their standard errors.

Table 4: Parameter and relative standard error estimates of equation 3 (θ) and equation 4 (γ, β).

	FRS		ELSA		BHPS	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
η^a ON						
female	0.05	0.03	0.331 ***	0.03	0.201 ***	0.08
spline age 73[1]	0.051 ***	0.00	0.008	0.01	0.011	0.01
spline age 73plus[1]	0.047 ***	0.00	0.066 ***	0.00	0.079 ***	0.01
educated beyond compulsory schooling	-0.107 ***	0.03	-0.201 ***	0.04	-0.182 **	0.08
income spline 1[2]	-0.083 ***	0.03	-0.053 *	0.03	-0.165 **	0.07
income spline 2[2]	-0.239 ***	0.05	-0.179 ***	0.04	-0.276 ***	0.10
whether home owner	-0.216 ***	0.04	-0.329 ***	0.04	-0.127	0.09
whether partner de facto lives in hh	0.032	0.03	-0.029	0.04	-0.087	0.08
whether somebody other than single/couple in hh	0.285 ***	0.05	0.087 *	0.05	0.119	0.11
R ON						
η	1.838 ***	0.09	1.24 ***	0.07	1.884 ***	0.24
female	0.193 *	0.12	0.107	0.142	-0.224	0.32
spline age 73[1]	0.209 ***	0.04	0.233 ***	0.045	0.229	0.14
spline age 73plus[1]	0.061 ***	0.01	0.042 ***	0.013	0.005	0.03
educated beyond compulsory schooling	0.021	0.12	-0.122	0.147	0.269	0.34
(ln) income spline 1[2]	-0.127	0.08	-0.025	0.126	0.089	0.17
(ln) income spline 2[2]	-0.953 ***	0.25	-0.629 **	0.284	-1.15 **	0.55
whether home owner	-0.324 ***	0.11	-0.061	0.141	-0.603 *	0.34
whether partner de facto lives in hh	-0.131	0.12	0.241 *	0.143	-0.265	0.34
whether somebody other than single/couple in hh	-0.249	0.18	0.417 ***	0.188	0.65 *	0.39
Thresholds	[Not showed here]					
Loglikelihood	-16,872.51		-31,472.27		-6,176.26	
H0 Scaling Correction Factor	0.99		1.04		1.00	
observations	7,327		5,152		1,042	
Number of Free Parameters	36		68		64	
Akaike (AIC)	33,817.01		63,080.55		12,480.52	
Bayesian (BIC)	34,065.39		63,525.75		12,797.25	
Sample-Size Adjusted BIC (n* = (n + 2) / 24)	33,950.99		63,309.67		12,593.98	

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[a] variance of η_j is constrained to be equal to 1 for defining the metric of the latent factor.

[1] Cut-off set to 73, which is the median age observed in the pooled sample of BHPS, ELSA and FRS.

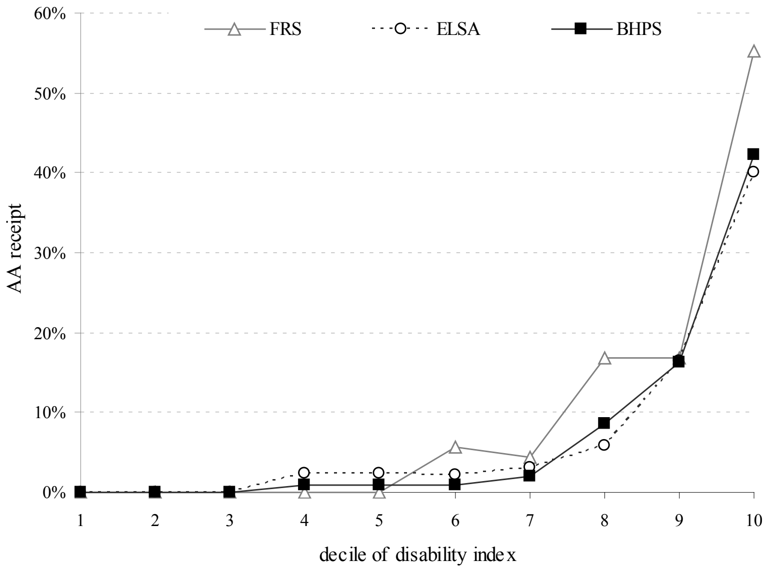
[2] Cut off set to exp(£513.86), which is the median pre benefit income observed in the pooled sample of BHPS, ELSA and FRS.

Women display a higher disability index η than males, although the difference is significant only for ELSA (0.33) and BHPS (0.20). The conditional mean of η increases with age: using a *spline* function of age, with a single knot at 73 years (the median age observed in the pooled samples), the FRS describes quite a linear relationship between age and disability; in the case of the ELSA and the BHPS a higher and significant relationship between age and disability is found only for the oldest segment of population. More educated individuals and those with higher per capita pre-benefit income display a lower disability index, providing evidence of a living standards gradient in disability, consistent across surveys. Being a home owner –a proxy indicator of living standards- decreases the conditional mean of η, although the estimated coefficient is statistically significant only in the FRS. Being married does not appear to contribute significantly in explaining the level of disability; instead, the presence of somebody other than the partner in the household is generally associated with a higher disability score[8].

Estimates for equation (4), describing the relationship of AA receipt with socio economic characteristics and latent disability, are reported in the bottom panel of Table 4. We used a set of socioeconomic variables, defined comparably between surveys, informed by previous analysis of AA receipt (Pudney, 2009) and claiming behavior generally (Hancock et al., 2005).

Under each survey's heading, estimates of coefficients β and γ and their standard errors are reported. Being in receipt of AA is clearly disability-related in each of the considered surveys: moreover, disability consistently emerges as the key variable in explaining AA receipt. Other things being equal, people experiencing a more severe disability score are more likely to be in receipt of AA, as shown in Figure 1.

Figure 1: % of people in receipt of AA by severity of their disability status



Note: AA receipt refers to the mean calculated for each survey-specific decile of the latent disability index.

[8] However, the exclusion of this variable leads to little change in the coefficients associated with the other SES characteristics.

Although disability might raise barriers to claiming and at the same time might reduce individuals' capacity to benefit from additional cash income, evidence supporting AA successful targeting to disabled people emerges consistently, irrespective of the survey data source.

In addition, the probability of receiving AA is, other things equal, overall lower for higher income individuals. The use of a spline function of income –with a single knot again corresponding to median income- allows for non linearity in the negative correlation. While the income coefficient is never significant for lower incomes, a significant and negative coefficient is found for higher incomes in all the three surveys. Such finding supports the idea that for those with poor economic resources, there is not a gradient in AA receipt. However, for higher pre-benefit income levels, the availability of additional pre-benefit income makes people less likely to receive AA, other things equal. In other words, although AA is a non means tested benefit, its assignment mechanism *de facto* reproduces the effects of means testing for those in the top half of the income distribution.

Whether receipt of AA is gender-related remains unclear: in the FRS, females are more likely to be in receipt of AA than males, but neither the ELSA nor the BHPS provides evidence of a significant relationship. Age of respondents in the FRS and ELSA samples affects the probability of being in receipt of AA non-linearly: the probability of being in receipt increases sharply with age among those aged between 65 and 73 in FRS and ELSA whereas, other thing equal, the age effect is lower among those aged 73 and over.

No evidence of a significant association between the level of education and AA receipt is found. In other words, having controlled for other characteristics (e.g. individual's disability and economic resources, etc.) we do not find evidence supporting the idea that education might ease claiming or that the stigma of claiming might be higher for the more educated. However, the fact that coefficients are not statistically significant might hide the presence of both effects, indistinguishable with the data at hand, acting in opposite directions. Owning one's home rather than renting reduces significantly the probability of being in receipt of AA both in the FRS and the BHPS. This might reflect the higher financial independence of home owners reducing the probability of claiming AA. However, a degree of heterogeneity appears in the magnitude of the coefficient across surveys: for instance, the effect in FRS (-27.7%) is about one half of the effect found in the BHPS sample. Finally, the presence of a partner or any other members in the households does not seems to significantly increase or decrease the probability of receiving AA in the FRS, whereas a positive and significant association is found for the ELSA dataset and – only for members other than the partner- in the BHPS.

5. Controlling for sample composition

Part of any cross-survey difference or similarity in the conditional probability of AA receipt could arise because of differences in the distribution of conditioning covariates in each sample, rather than from differences in what survey specific variables are picking up. There are several reasons why the sample distribution of conditioning covariates might vary across surveys. First, the three surveys differ in terms of sample frame: while both in the case of FRS and BHPS (wave 1), clustered random samples were selected from the Royal Mail's small users's PAF (Postcode Address File), the target sample of ELSA wave 1 consisted of people born on or before 29 February 1952 and their households selected from three separate survey waves of the Health Survey for England (HSE) each drawn from the PAF. Sample design is also based on different stratification variables.

Second, underlying trends affecting the characteristics of each survey target population might play a role. For example, while the FRS sampling was aimed at capturing a 'fresh' section of the current population characteristics, as of 2002, the BHPS target sample for wave 12 should represent the characteristics of wave 1 sampled households members (and additional members that joined -or where born from household members), as of 1991, brought forward for 11 years, up to 2002.

Non-response and differential attrition might also come into play: for example, in the case of BHPS, only 66% of wave 1 respondents provided a full interview in wave 12 (Lynn et al. 2006). Around 40% of the designed sample members, selected from HSE surveys, dropped-out from the ELSA sample at the first wave (Taylor et al. 2003). Response rate in FRS 2002/3 was 64% of eligible households.

In order to overcome all of the above potential sources of bias, one possible approach is to use matching techniques, allowing to obtain survey specific sub-samples balanced along a set of commonly observed socio-economic characteristics, thought to influence both disability and AA receipt. We follow this route in order to obtain, for each sample taken in turn as a 'baseline'-say the FRS sample-, two matched 'control' sub-samples (one from the BHPS and one from the ELSA) characterised by the same distribution of covariates as that observed in the FRS 'baseline' sample. We repeat the same exercise taking each survey sample as the 'baseline" and building corresponding 'same-covariates-distribution' sub-samples from the remaining two surveys. We end up with six pair-wise matched couples of samples.

Matching is aimed at minimising the difference in the propensity score (Rosenbaum and Rubin, 1983), defined as the conditional probability for an individual of being observed in the sample t, rather than in sample $c \neq t$, given the set of characteristics Z_i, observable in each sample t and c. In our framework, the propensity score is:

$$Pr(i \in t|\ Z,\ i \in (tUc)\ )$$

where t represent what has been referred to as the 'baseline' survey above. This probability is estimated parametrically using probit modelling and allowing the specification of the index function to adapt so that an adequate balancing of covariates can be obtained for each pairwise matching exercise. The use of the propensity score allows us to balance over a rich set of covariates, including age, gender, terminal education age, partnership, employment status, house tenure, presence of further household members, income, and their interactions.

Matching is performed with no replacement. Given the non trivial differences in sample size of the three surveys (with the FRS and ELSA sample being almost seven and five times bigger- respectively- than the BHPS) the 'no replacement' option ensures that the extent of variation in conditioning covariates is not spuriously altered as a consequence of the matching algorithm. This comes at the cost of reducing sample size for the two successfully matched samples, as all of the unmatched baseline observations are discarded in the following analysis. We also impose a caliper of 0.001 to the maximum distance in propensity scores accepted for the match to be retained. This methodological choice ensures that the quality of matching is not compromised and is given priority over sample size considerations. Results for the obtained probit estimates of the propensity score -for each of the six pair-wise matching implemented- together with the sample number of the baseline and `control' samples involved and *t test* on the means of conditioning covariates are omitted for sake of brevity but can be obtained upon request from the authors. *T-tests* for the equality of means between each 'baseline' survey and each other survey used as 'control' point out the efficacy of the implemented matching algorithm in ensuring that the balancing of conditioning covariates is achieved; the percentage of baseline-survey observations for which no adequate match was found, varies remarkably according to which suveys is being used as baseline and as a control: from below 1% when BHPS is used as 'baseline' (because of the much larger sample size of both the ELSA and FRS as 'controls'); to about 85% when BHPS is used as control for FRS as baseline. This is mostly due to the "no replacement" option, and to a minor extent, to the imposition of a caliper.

On each of the six sets of 'baseline' and 'control' balanced-composition samples, we repeated estimation of the system of equations (1) (3) and (4). Results obtained for equations (1) and (3), broadly confirm the patterns described in Section 4, with mobility indicators playing predominant role as indicators of latent disability and an age and living standards gradient in disability, consistently across different samples. Estimates obtained for the β and γ coefficients of equation

(4) are reported in Table 5: the top panel reports estimated obtained on samples mimicking the FRS sample composition; the central panel those obtained on samples mimicking the ELSA sample composition and the bottom panel those mimicking the BHPS sample composition. The significance of coefficients is inevitably affected by different sample sizes, ranging from about one thousand observations when the BHPS is taken as baseline or used as control, to samples resulting from the FRS-ELSA matching, about five times larger in size. The existence of a positive disability gradient in AA receipt is confirmed in each of the 12 considered samples: estimates for the γ coefficient are positive, significant and remarkably similar in size. The negative income gradient is also confirmed, whenever the income coefficient is significant (generally for high incomes, rather than low incomes). The negative association between living standards and receipt of AA is again confirmed from the sign of the home-ownership coefficient, whenever significant. Significant – although in some samples only- coefficients are also found for age, increasing the probability of receipt AA, and the presence of other household members, increasing the probability of receiving AA with the only exception of the coefficient obtained on FRS data, when matched to the BHPS sample as control. Overall, although matching reduces sample size with consequent loss of significance for various coefficients, the broad patterns observed on matched samples are confirmed once sample composition is controlled for.

Table 5: Parameter and relative standard error estimates of equation 3 (γ_j, β_j) obtained in the post-matching samples.

	FRS sample composition							
S	FRS		ELSA		BHPS		FRS	
N	5048		*5048*		*1040*		*1040*	
	coef.	*SE*	*coef.*	*SE*	*coef.*	*SE*	*coef.*	*SE*
η	1.875 ***	0.12	1.524 ***	0.1	1.877 ***	0.24	2.016 ***	0.27
female	0.203	0.15	0.096	0.1	-0.225	0.32	0.423	0.32
spline age 73[1]	0.246 ***	0.05	0.224 ***	0.0	0.23	0.14	0.034	0.08
spline age 73plus[1]	0.05 ***	0.01	0.043 ***	0.0	0.005	0.03	0.051	0.03
educated beyond compulsory schooling	-0.032	0.15	-0.131	0.1	0.275	0.34	0.147	0.35
(ln) income spline 1[2]	-0.112	0.10	-0.052	0.1	0.038	0.17	0.043	0.16
(ln) income spline 2[2]	-1.234 ***	0.32	-0.585 **	0.3	-1.135 **	0.55	-0.173	0.53
whether home owner	-0.213	0.14	-0.069	0.1	-0.606 *	0.34	-0.761 **	0.33
whether partner de facto lives in hh	-0.041	0.15	0.23	0.1	-0.262	0.34	-0.65 *	0.34
whether somebody other than single/couple in hh	-0.195	0.20	0.384 ***	0.2	0.654 *	0.39	-0.622	0.51

	ELSA sample composition							
S	ELSA		BHPS		ELSA		FRS	
N	*1034*		1034		*4981*		*4981*	
	coef.	*SE*	*coef.*	*SE*	*coef.*	*SE*	*coef.*	*SE*
η	1.772 ***	0.07	1.89 ***	0.24	1.531 ***	0.07	1.872 ***	0.12
female	-0.201	0.14	-0.215	0.32	0.086	0.14	0.084	0.15
spline age 73[1]	0.206 *	0.05	0.228	0.14	0.221 ***	0.05	0.247 ***	0.05
spline age 73plus[1]	0.048	0.01	0.005	0.03	0.046 ***	0.01	0.063 ***	0.01
educated beyond compulsory schooling	-0.272	0.15	0.247	0.34	-0.126	0.15	0.117	0.15
(ln) income spline 1[2]	-0.138	0.13	0.084	0.17	-0.077	0.13	-0.121	0.12
(ln) income spline 2[2]	-0.284	0.28	-1.071 *	0.55	-0.634 **	0.28	-1.115 ***	0.33
whether home owner	0.449	0.14	-0.598 *	0.34	-0.056	0.14	-0.355 **	0.14
whether partner de facto lives in hh	0.069	0.14	-0.267	0.34	0.244 *	0.14	-0.047	0.15
whether somebody other than single/couple in hh	0.095 ***	0.19	0.644 *	0.39	0.324 ***	0.19	-0.144	0.20

	BHPS sample composition							
S	BHPS		ELSA		BHPS		FRS	
N	1034		*1034*		*1037*		*1037*	
	coef.	*SE*	*coef.*	*SE*	*coef.*	*SE*	*coef.*	*SE*
η	1.873 ***	0.24	1.688 ***	0.07	1.877 ***	0.24	2.226 ***	0.34
female	-0.226	0.32	0.039	0.14	-0.225	0.32	-0.105	0.35
spline age 73[1]	0.225	0.14	0.133	0.05	0.23	0.14	0.252 **	0.11
spline age 73plus[1]	0.006	0.03	0.02	0.01	0.005	0.03	0.108 ***	0.03
terminal education age	0.259	0.34	-0.519	0.15	0.275	0.34	0.046	0.36
(ln) income spline 1[2]	0.083	0.17	-0.438 **	0.13	0.038	0.17	-0.021	0.27
(ln) income spline 2[2]	-1.128 **	0.55	-0.048	0.28	-1.134 **	0.55	-1.595 **	0.69
whether home owner	-0.602 *	0.34	-0.26	0.14	-0.606 *	0.34	-0.852 **	0.37
whether partner de facto lives in hh	-0.267	0.34	-0.438	0.14	-0.262	0.34	0.283	0.38
whether somebody other than single/couple in hh	0.647 *	0.39	0.384 ***	0.19	0.654 *	0.39	-0.174	0.52

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
See notes [a] [1] and [2] of Table 4 .

6 Conclusions

This work has aimed at contributing to the current British policy debate over reform prospects for the social care system by investigating the robustness of survey-based analysis of targeting of the current AA programme of cash support for older people with disabilities. We improve on previous analyses by acknowledging the latent nature of the disability status by which eligibility is assessed, and the fact that observable socioeconomic characteristics might influence both the probability of claiming, for a given disability status, and the severity of disability. The estimation of a structural equations model, in which a common underlying latent disability concept is reflected in survey-specific functional limitations indicators, allows a robust assessment of the disability and living standards gradient in AA receipt and investigation of the direct role played by other personal characteristics, beyond their indirect influence as correlates of disability.

Results confirm that the probability of receiving AA increases strongly with the severity of disability and decreases with living standards – especially for those in the top half of the income distribution – after allowing for the fact that higher living standards are also associated with lower disability. The robustness of our findings is guaranteed by the contemporaneous analysis of three different data sources with matching techniques used to remove the potential bias stemming from cross-survey differences in sample composition. Results from three alternative data sources with different disability indicators and different baseline distributions of conditioning covariates, point to the same pattern of receipt. Thus, despite their enormous differences in design and content, the three surveys have a coherent story to tell and appropriate statistical tools do allow us to extract that story from partial and noisy indicators of the underlying disability state.

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