UPDATING THE FUEL POVERTY INDICATOR FOR ENGLAND

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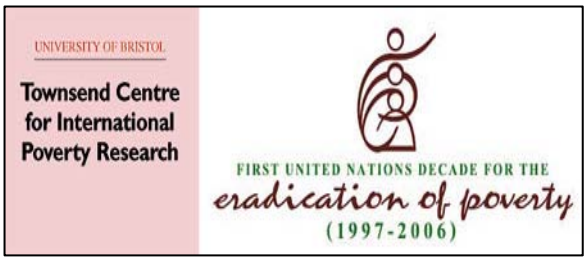

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CONTENTS

TABLES AND FIGURES

Overview

The Fuel Poverty Indicator (FPI) predicts the incidence of fuel poverty at ward and sub-ward level across England and, since it was published in 2003, has become a widely used tool for informing affordable warmth policies and targeting fuel poverty programmes at a local level.

The FPI uses statistical modelling techniques to reflect more accurately than other local deprivation indices those aspects of income, household status, housing condition and fuel costs which combine to create fuel poverty. The FPI was first developed between 2000-2002 by the Centre for Sustainable Energy and the University of Bristol, based upon 1991 Census and 1996 English House Conditions Survey data. The recent publication of the 2001 Census combined with the new EHCS approach (which has moved to a process of continuous survey and bi-annual publication) offers an exceptional opportunity to update and upgrade the FPI, and therefore to improve the efficacy of the FPI as a predictive tool in a changing world.

This Report summarises progress in updating the fuel poverty indicator (FPI) for England. Specifically, Section One of this Report outlines the methodology adopted in updating the FPI and presents final results for both the 'Basic Income' and 'Full Income' versions of the FPI for England. Section Two of this Report presents the results of further exploratory work on fuel poverty in England using alternative definitions and indicators of fuel poverty based upon income equivalisation and existing best practice in the measurement of household income.

Section 1: Updating the Official Fuel Poverty Indicator

1.1 Introduction

The 2001 Census and the 2001 and later English House Condition Surveys have made a number of significant scientific and technical advances resulting in much more reliable and accurate estimates of small area fuel poverty than was previously possible, including:

1) The 2001 Census Output Area Geography

Unlike the 1991 Census, the 2001 Census groups household data by smaller and more comparable Output Areas (approximately 125 homes) which have common tenure and dwelling characteristics. This significantly improves the accuracy and predictive power of the FPI at a sub-ward level.

2) Improvements to 2001 Census indicators of fuel poverty
The 2001 Census includes new and improved questions potentially associated with fuel poverty, including new questions on general health, and improved questions on under-occupancy and unemployment.

3) The ability to link post coded data to the 2001 Census Output Areas
It is envisaged that a key indicator of fuel poverty is the age and type of dwellings. Although the age of dwellings was not collected in the 2001 Census, this information is available at postcode level from Housing Data-sources such as RESIDATA.

4) Improvements to energy use modelling and income measurement in the 2003 EHCS
The new EHCS employs a more accurate model for calculating energy costs which allows for different heating regimes, regional variation in fuel prices and regional climatic variation. It also has more accurate data on income and Council Tax benefit receipts.

Based upon existing research into fuel poverty, it is therefore possible to estimate the vulnerability of different groups of households to fuel poverty using the 'improved' 2003 EHCS survey data and to apply the resultant survey weights to 2001 Census data at a variety of spatial scales. This was done using a logistic regression approach to predict the odds of fuel poverty for different household types, and then applying the results of these models (Full and Basic FPI) to 2001 Census data. The approach is sometimes referred to as synthetic modelling. Before carrying out the regression analysis, the following steps were undertaken:

- **Data harmonisation.** Harmonisation of data from the 2003 English EHCS to the 2001 UK Census
- **Re-weighting.** Post-stratification weighting of 2003 EHCS data to the 2001 UK Census
- **Residata matching.** Matching of Residata post-coded data on dwelling type, age and property value to 2001 Census OA geography
- **Selecting optimal splits.** The selection of an optimal subset of variables to predict fuel poverty (e.g. using Exhaustive CHAID)

Sections 1.2 to 1.7 describe the model specification in more detail, and Sections 1.8 and 1.9 present the results of the analyses for the 'full' and 'basic' income versions of the FPI.

1.2 Census-based Deprivation Indices

The approach adopted by the research builds upon earlier applications of this approach to 1991 Census data led by Professor Gordon at the University of Bristol (e.g. Baker et al., 2002). The approach also draws heavily upon a much broader body of research into census-based indicators of deprivation (e.g. Gordon, 1995; Lee et al., 1995). Census-based measures of deprivation are usually 'indirect' or 'proxy' measures of deprivation in that they typically measure characteristics associated with poverty (e.g. health status, overcrowding, etc.), rather than poverty itself. As such, their adequacy is dependent upon the model fit of the survey data used to derive the census weightings.

Because census-based approaches are based upon indirect measurement, individual components of the indicator need to be:

1. Weighted to reflect the different probability each component group has of suffering deprivation; and

2. Additive so that an indicator consisting of two variables should yield higher fuel poverty rates for the variables together than for either variable separately.

Weighted indicators also have the advantage that the results are much easier to understand. For example, it allows the researcher to make the statement that "15% of households in the South West live in fuel poverty", rather than "the South West has a fuel poverty Z score of -2.6". This protocol was successfully followed in our previous research which developed the original FPI based on the 1991 Census (Baker et al., 2002). In doing so, a number of a priori assumptions were made about the type of household most likely to live in fuel poverty based upon existing research findings.

1.3 Model Specification

Scientific approaches to the measurement of fuel poverty are based upon a set of a priori assumptions about the nature of fuel poverty drawn from existing research evidence. Ideally, we would seek to develop a measurement model of fuel poverty using one dataset and test the model using independent data. The overall comparability of the approach adopted by this research for developing the 2001 census-based FPI with the earlier 1991 FPI (e.g. Baker et al., 2002), is therefore a major strength of the research.

Existing studies on individuals' and households' propensity to live in fuel poverty (e.g. Boardman, 1991; DTI/DEFRA, 2001; NEA, 2001; Wilkinson et al., 2001; Sefton, 2002) suggest that it is possible to identify two categories of fuel poverty:

1. *People with a relatively low income.* Groups known to suffer from high rates of relative poverty, e.g. lone parents, unemployed people, are also likely to suffer from high rates of fuel poverty. However, there are exceptions. Some social housing tenants, for example, live in properties with high energy efficiency standards, meaning that although they may have low incomes, they do not live in fuel poverty.

2. *People with low/moderate incomes living in energy inefficient housing.* This group may have an overall standard of living above the relative poverty threshold. However, the poor energy efficiency standards of their housing (coupled with, in some cases, under-occupancy) may push this group into fuel poverty. Single pensioners living in poorly insulated older dwellings make up the bulk of this group. Fuel poverty, in this case, is largely a problem of heating unmodified pre-WWII housing stock, combined with relatively low pension incomes.

1.4 Harmonisation of Definitions

Synthetic modelling of fuel poverty at a small area level involves determining the best sub-set of predictors of fuel poverty (based upon regression analysis) using the 2003 ECHS, and applying these weightings to 2001 Census small area data. In order to do this, it is clearly essential that the operationalisation of measures used in the analysis of the ECHS is as consistent as possible with the definitions and measures adopted by the 2001 Census. Hence, measuring instruments need to be harmonised across these datasets.

Official surveys are designed to meet different needs, and have been commissioned by a range of departments, resulting in important definitional differences across measures. These can have important effects upon the distribution of key classificatory variables used in the construction of weighted, census-based indices. In particular, the definitional basis for household-level statistics in the 2001 Census is very different from that adopted within the 2001 EHCS. In 2001, the concept of Household Reference Person (HRP) replaces Head of Household used in 1991. This meant substantial and time-consuming re-coding of the 2003 EHCS data was necessary to ensure that household-level indicators used to weight census data was comparable across data sources. [A copy of the SPSS syntax used to harmonise the 2003 EHCS data to the 2001 Census definition of HRP, as laid before Parliament, is available from the research team.]

As with the concept of HRP, the definition of many other potential key predictors of fuel poverty in England is also somewhat different in the 2001 Census compared with the 2003 EHCS. The research team assessed the compatibility of 2003 EHCS (and 2000-02 FRS) data with ONS 2001 Census definitions and outputs based upon a systematic review of census tables using the SASPAC software package. In total, 43 question areas within the 2001 Census required detailed examination to enable consistent analysis of the two data sets and definitions applied. With respect to the EHCS these included:

- Household composition
- Household tenure status
- Employment status (HRP)
- Household shares accommodation
- Household shares WC or bath/shower
- Household lacks central heating
- Limiting illness (respondent)
- Ns-Sec of HRP[1]
- Dwelling type
- Period of construction of dwelling
- Number of rooms in accommodation
- Highest floor level of accommodation
- Occupancy rating
- Highest educational attainment

[A copy of the EHCS/FRS/CoP harmonisation routine is available from the research team.]

[1] Within the 2003 EHCS information on NS-Sec is only gathered from the HRP and partner. In a small number of cases (2.7% of households) values for NS-Sec of 2001 Census HRP have therefore been imputed on the basis of regression imputation

1.5 Data Harmonisation

The harmonisation of EHCS and 2001 Census sources has *two* key components:

1. harmonisation of definitions (as described above), and;
2. harmonisation of the data itself in terms of the observed characteristics of the sample with respect to key grouping variables.

The weights derived from the EHCS models clearly need to be estimated on the same basis as the data to which they are subsequently applied, namely 2001 Census small area data. In order to ensure comparability and consistency of data sources between the 2003 EHCS and 2001 Census, it is necessary to re-weight 2003 EHCS data to reflect the social-demographic distribution of the English resident household population in 2001, with respect to key variables known to be associated with fuel poverty.

In the analyses that follow a post-stratification re-weighting was applied to the 2003 EHCS data to ensure consistency with 2001 Census estimates for the following characteristics:

- **Household type (7 categories):** Single; Single pensioner; All pensioners; Couple, no dependent children; Couple with dependent children; Lone parent with dependent children; Other.
- **Tenure Status (5 categories):** Owner; Owns with mortgage; Private renter; Local Authority renter; Registered Social Landlord / Housing Assoc. renter.
- **Employment status (4 categories):** In work (full/part-time); Unemployed; Full-time student; Economically inactive.

This re-weighting restores the 2003 EHCS sample to the observed frequencies for England obtained from the 2001 Census. Of the total valid sample, 3,124 (19.6%) respondents were weighted with values greater than 3, with all values in the range 0.18 to 4.76. Heavily weighted cases (with values of 3 or more) were primarily concentrated amongst 'other' household types (45%), as well as amongst mortgage holders (42%), and those in employment (27%). This is to be expected, since one of the key purposes of the English House Condition Survey (measuring progress towards the Decent Homes standard) involves over-sampling social rental tenants whose social characteristics differ in key respects from owner occupiers (*e.g.* with respect to employment status) and private rental tenants (*e.g.* with respect to household type).

Table 1 (*below*) shows the overall sample sizes for the un-weighted and weighted (post-stratified) data for key predictor variables.

Table 1: EHCS Sample Sizes by Household Composition, Housing Tenure and Employment Status of HRP (N).

	Un-weighted data	EHCS weight	2001 Census weight	Inflation factor
Single pensioner	2413	2114	2292	1.05
Single person	2272	2177	2504	0.91
All pensioners	1428	1583	1424	1.00
Couple, no dependent children	2684	3058	2834	0.95
Couple with dependent children	3562	3884	3316	1.07
Lone parent	1681	1173	1023	1.64
Other household type	1910	1961	2556	0.75
Owner	4872	6842	4126	1.18
Owns with mortgage	3197	4601	7368	0.43
Private rental	2099	1513	1518	1.38
LA rental	3478	1799	2029	1.71
RSL rental	2303	1193	908	2.54
Working	9223	10181	11161	0.83
Unemployed	631	422	464	1.36
Full-time student	164	123	105	1.57
Economically inactive	5931	5222	4218	1.41

1.6 Matching of Residata to 2001 Census

A key indicator of fuel poverty which was not measured in the 2001 Census is the age of dwellings. Older houses (particularly pre-1920 construction) are more likely to be fuel inefficient than more modern dwellings[2]. Although the age of dwellings was not collected in the 2001 Census this information is available at postcode level from RESIDATA. The team was able to accurately convert this post coded information to 2001 Census Output Areas and other geographies using the Postcode to Output Area (PC to OA) lookup tables. Similar data linkages were possible with 1991 census data but they were much less accurate as 1991 Enumeration Districts were not based on postcodes. In contrast the Automated Zoning Procedure (AZP) used in the construction of 2001 Output Areas ensured that unit post codes were grouped together into the larger census output areas.

The research team successfully matched the Residata unit postcode data on over 1.15 million 2001 Output Areas, representing a full or partial match rate of virtually 100%. (For 13 of the 165,000+ Output Areas, Residata records were missing and were therefore imputed on the basis of mean Lower Super Output Area values). As a result it is possible to include 'age of dwelling' and 'property valuation' within the final 'full' and 'basic' income versions of the FPI.

1.7 Exhaustive CHAID

CHAID is a popular analytic technique for performing classification or segmentation analysis. It has many potential applications in the social sciences, including the use of survey data to inform policy making through the development of decision rules to select key

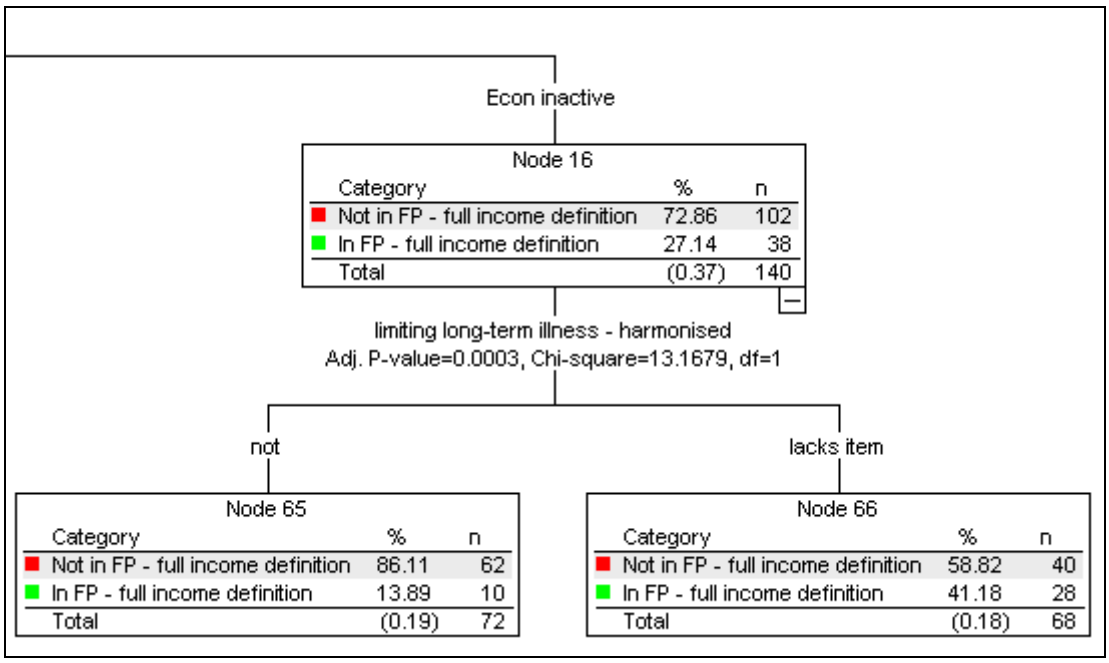
[2] A major reason for this is the use of solid wall, as opposed to cavity wall, construction in older buildings.

predictors. CHAID stands for Chi-square Automatic Interaction Detection and is an exploratory data analysis method used to study the relationship between a dependent variable and a set of predictor variables. CHAID modelling selects a set of predictors and their interactions that optimally predict the variability in the dependent measure.

The developed CHAID model is a classification tree that shows how major 'types' formed from the independent variables differentially predict a criterion or dependent variable. Exhaustive CHAID is an extension and development of CHAID but differs in the approach adopted to merging categories for the target variable in order to determine optimal groupings (see Biggs et al., 1991). One application of exhaustive CHAID, segmentation analysis, identifies the best splits in nominal and categorical predictor variables on the basis of the Pearson Chi Square statistics (or equivalent tests for continuous data). (All CHAID analyses described in this report were performed using SPSS Answer Tree v3.1).

Consider the example illustrated in the box below. This shows one segment or 'branch' of an exhaustive CHAID tree which seeks to identify optimal splits in a set of socio-economic predictors of fuel poverty (full income) on the basis of Chi square tests (not shown). This branch considers only single person households who are also economically active. Amongst respondents in this group, CHAID estimates the overall fuel poverty rate as 27.1%. This estimate is significantly different from that for other respondents on the basis of Pearson's Chi Square test. Within this category, 41.2% of respondents reporting a long-term limiting illness were fuel poor compared with 13.9% of those free from limiting illness. Using exhaustive CHAID this approach can be generalised to produce a complete classification analysis of all cases. The resultant model may also be cross-validated by comparing estimates derived from several different sub-sets of the same dataset.

Figure 1: An Example of Exhaustive CHAID – Economic Activity and Long-Term Illness



The full results of exhaustive CHAID analysis are difficult to convey adequately within the confines of a brief report of this nature. From a policy perspective it is also useful to

investigate which nodes or clusters are associated with the greatest concentrations of fuel poverty. This can be done using the electronic file (available from the research team) but some exemplars of this approach are shown below. This shows the Node or segment number assigned, the proportion of respondents within this group classified as fuel poor based upon the Full Income FPI, and the characteristics of group membership:

- **Node 14 – 66% FPI poor:** Not in work; no central heating; single non-pensioner households
- **Node 46 - 60% FPI poor:** Not in work; no central heating; no qualifications; single pensioner households
- **Node 44 – 57% FPI poor:** Not in work; no central heating; single non-pensioner households; property value less than £80,000; low NS-Sec

1.8 Univariate Results

Initially, a range of variables were selected as potential predictors of fuel poverty on the basis of previous studies (e.g. DETR, 2000; NEA, 2000; Baker et al., 2002). As a result of the harmonisation schedule (*see above*) these variables were also measured in similar ways in the EHCS and the Census. The variables and their encodings are listed below, along with the following statistics:

1. The percentage within the sub-group FPI poor for both Basic Income (*Table 2*) and Full Income (*Table 3*), in comparison with all other sample members (Data Col. 1).
2. The Pearson Chi Square statistic for the relevant 2x2 table indicating the strength of association between measures compared with the out-group (Data Col. 2).
3. The risk estimate indicating the odds of being fuel poor for each sub-group in comparison with the out-group comprising all other sample members (Data Col. 3).

Table 2a: Univariate Statistics for FPI Basic Income: Frequencies (%), Chi Square and Relative Risk Ratios for 2x2 Tables.

	VARIABLE	%	X^2	Risk
Property value	Less than £40,000	19.3	336	3.88
	£40,001 to £60,000	11.8	69	1.98
	£60,001 to £80,000	9.5	22	1.49
	£80,001 to £100,000	5.2	9	0.72
	£100,001 to £120,000	3.8	24	0.51
	£120,001 to £200,000	4.5	55	0.56
	£200,001 to £500,000	3.6	63	0.45
	More than £500,000	3.7	4	0.52
NS-Sec (HRP)	Higher prof./managerial	1.2	123	0.15
	Lower prof./managerial	2.6	110	0.31
	Intermediate	6.8	<1	[0.98]
	Small employers/own account	6.1	2	[0.86]
	Lower supervisory/technical	7.3	<1	[1.07]
	Semi-routine	11.2	91	1.96
	Routine	12.9	161	2.40
	Other	12.5	<1	[1.93]

Household composition	Single pensioner	15.9	336	3.31
	Single person	15.4	334	3.24
	All pensioners	4.1	20	0.55
	Couple, no dep. children	2.5	104	0.30
	Couple with dep. children	1.1	213	0.13
	Lone parent	12.8	59	2.11
	Other household	2.1	109	0.25
Housing tenure	Owner	1.3	269	0.14
	Owns with mortgage	6.3	8	0.84
	Private renter	11.1	47	1.82
	LA renter	15.1	242	2.93
	RSL renter	11.9	37	1.91
Employment status (HRP)	In work (HRP)	2.1	1322	0.10
	Unemployed (HRP)	42.2	923	11.78
	Student	19.0	24	3.21
	Inactive	15.4	638	4.52
Hhld shares accomodation		29.0	24	5.55
Hhld shares WC or bath/shower		33.3	26	6.79
Hhld no central heating		19.5	343	3.93
Limiting long-term illness (resp.)		14.8	332	3.16
Dwelling type	Detached	5.2	25	0.68
	Semi-detached	5.6	16	0.75
	Terrace	8.2	18	1.32
	Flat	9.1	18	1.42
	Part/other	11.0	13	1.69
Year Dwelling Built	Up to 1850	7.5	<1	[1.09]
	1851 to 1899	10.2	29	1.62
	1900 to 1919	10.0	23	1.57
	1920 to 1944	7.0	<1	[1.01]
	1945 to 1964	8.6	19	1.36
	1965 to 1974	5.7	6	0.79
	1975 to 1980	5.4	4	[0.76]
	1981 to 1990	2.0	54	0.26
	1991 to 2006	1.5	44	0.20
Number of rooms	Up to 2	11.1	<1	[1.69]
	3	8.3	8	1.26
	4	8.0	6	1.21
	5	6.6	<1	[0.94]
	6	5.8	5	0.81
	7	8.4	8	1.27
	8 or more	5.3	20	0.70
Highest Floor	Basement	7.1	<1	[1.03]
	Ground	6.6	19	0.68
	First	9.1	8	1.38
	Second	8.2	<1	[1.21]

	Third	9.5	2	[1.41]
	Fourth or higher	20.6	31	3.54
Occupancy rating	Occupancy +2	7.3	2	[1.10]
	Occupancy +1	6.4	3	[0.89]
	Occupancy 0	7.5	3	[1.12]
	Occupancy -1	2.3	12	0.31
	Occupancy -2	1.9	2	[0.26]
Educational attainment (resp.)	No qualifications	12.2	353	3.15
	Level 1	5.7	13	0.76
	Level 2	4.9	14	0.66
	Level 4/5	2.0	183	0.22
	Other qual/missing	5.6	2	0.79

[ ] = Not significant at .05 level.

For example, with respect to the Basic Income FPI (*Table 2*), 15.9% of pensioners are fuel poor in comparison with 5.3% of the total weighted sample. The associated Chi Square statistic (336) is highly significant and – again compared with all other sample members – single pensioners are more than three times (3.31 to 1) more likely to be fuel poor. A similar interpretation pertains to Full Income (*Table 3*). In both cases, certain sub-groups stand out as especially vulnerable to fuel poverty and these confirm many of the principal findings arising from earlier research (e.g. DETR, 2000; NEA, 2000; Baker et al, 2002). These 'at risk' groups include:

- Households headed by an unemployed and economically inactive person
- Respondents without educational qualifications
- Those lacking household facilities or central heating
- Single person, single pensioner and lone-parent households
- Households living in detached or older accommodation

However, it is clearly important to consider the simultaneous effects of the 'risk markers', since many of these variables are themselves inter-correlated. Multivariate analysis techniques appropriate for use with non-continuous data were therefore used to address this. The next section therefore discusses the results of the binary logistic regression analysis.

Table 2b: Univariate Statistics for FPI Full Income: Frequencies (%), Chi Square and Relative Risk Ratios for 2x2 Tables.

VARIABLE		%	X^2	Risk
Property value	Less than £40,000	13.3	124	2.62
	£40,001 to £60,000	9.6	40	1.76
	£60,001 to £80,000	8.5	21	1.50
	£80,001 to £100,000	4.5	10	0.69
	£100,001 to £120,000	3.7	16	0.57
	£120,001 to £200,000	4.8	21	0.70
	£200,001 to £500,000	4.0	30	0.58
	More than £500,000	4.9	<1	[0.79]
NS-Sec (HRP)	Higher prof./managerial	1.7	82	0.24
	Lower prof./managerial	2.6	80	0.36
	Intermediate	6.9	3	[1.17]
	Small employers/own account	6.5	<1	[1.08]
	Lower supervisory/technical	6.3	<1	[1.04]
	Semi-routine	9.4	59	1.79
	Routine	9.7	63	1.85
	Other	6.3	<1	[1.02]
Household composition	Single pensioner	16.7	515	4.37
	Single person	11.9	169	2.52
	All pensioners	5.3	2	[0.84]
	Couple, no dep. children	2.9	64	0.40
	Couple with dep. children	1.1	183	0.14
	Lone parent	5.7	<1	[0.92]
	Other household	1.9	96	0.26
Housing tenure	Owner	1.7	186	2.14
	Owns with mortgage	8.1	92	1.89
	Private renter	8.2	12	1.41
	LA renter	7.4	6	1.26
	RSL renter	3.9	9	0.60
Employment status (HRP)	In work (HRP)	2.2	1001	0.12
	Unemployed (HRP)	27.2	367	6.40
	Student	16.2	19	2.99
	Inactive	14.0	611	4.73
Hhld shares accomodation		26.7	22	5.60
Hhld shares WC or bath/shower		33.3	31	7.70
Hhld no central heating		18.9	392	4.40
Limiting long-term illness		12.6	251	2.91
Dwelling type	Detached	6.1	<1	[0.99]
	Semi-detached	5.6	3	[0.87]
	Terrace	7.1	12	1.27
	Flat	4.5	11	0.69
	Part/other	8.9	7	1.52
Year Dwelling Built	Up to 1850	7.2	1	[1.19]
	1851 to 1899	9.9	42	1.81
	1900 to 1919	9.7	36	1.76
	1920 to 1944	6.9	4	[1.17]
	1945 to 1964	7.2	9	1.26

	1965 to 1974	4.0	22	0.60
	1975 to 1980	4.4	6	0.69
	1981 to 1990	1.1	63	0.16
	1991 to 2006	1.4	37	0.21
Number of rooms	Up to 2	5.6	<1	[0.90]
	3	6.2	<1	[1.09]
	4	6.7	2	[1.12]
	5	6.0	<1	[0.98]
	6	4.9	7	0.77
	7	8.2	18	1.45
	8 or more	5.3	6	0.81
Highest Floor	Basement	6.3	<1	[1.03]
	Ground	6.2	<1	[1.11]
	First	5.1	2	[0.82]
	Second	4.1	2	[0.65]
	Third	6.1	<1	[0.99]
	Fourth or higher	13.2	9	2.35
Occupancy rating	Occupancy +2	7.9	50	1.59
	Occupancy +1	5.9	<1	[0.95]
	Occupancy 0	4.3	29	0.63
	Occupancy -1	0.9	17	0.13
	Occupancy -2	1.9	2	[0.29]
Educational attainment	No qualifications	11.1	352	3.36
	Level 1	4.2	34	0.61
	Level 2	4.4	11	0.68
	Level 4/5	2.2	132	0.28
	Other qual/missing	5.0	2	[0.80]

[ ] = Not significant at .05 level.

1.9 Multivariate Modelling of Basic and Full Income FPI

Investigating the simultaneous effects of the 'risk markers' associated with fuel poverty was achieved by using multivariate binary logistic regression analysis. This involved selecting variables through backward stepwise selection, using the likelihood ratio method (see e.g. Hosmer & Lemeshow, 1989). Before running the logistic regression models, the research team checked for multivariate outliers through an examination of 'studentised' residuals[3]. This resulted in the deletion of a further 30 cases for the Basic Income FPI model, and 36 cases for the Full Income FPI model, leaving a total of 15,927 (Basic) and 15,921 (Full) cases available for analysis.

Modelling Strategy

Initial model fitting was undertaken using backward stepwise logistic regression (likelihood ratio method) in which all parameters were entered in one block. Following suitable checks

[3] A model residual is the difference between the predicted value for a case specified by the model and its observed value. The 'studentized' residual, named after William Gosset, (writing under the pseudonym 'student'), is derived by dividing the residual by the standard error of the residual with that case deleted. Inspection of studentized residuals is an important means of detecting outliers.

for multicollinearity and heteroskedasticity, significant model coefficients were then entered in one block in two separate logistic regression models[4]. A variety of approaches to modelling these data were tested, as described below:

- ***Model 1 – Global.*** A single model is fitted to the 2003 EHCS data and the single set of weightings derived from this model are then applied to 2001 Census data
- ***Model 2 – Settlement Type.*** Separate models are developed for different settlement types by using a modified version of the 2005 ONS Urban-Rural Classification (Bibby & Shepherd, 2004). The settlement types selected were: London GOR; Urban (settlements of greater than 10,000 residents); 'suburban' (small towns and urban fringes); rural (villages and dispersed populations). The weightings derived from these distinct models are then applied to the 2001 Census data.
- ***Model 3 – Government Office 'Super-regions'.*** Separate models are developed for the following combinations of Government Office Regions: London/East of England/South East; North East/Yorkshire and Humberside; North West; West Midlands/East Midlands/South West. The weightings derived from these distinct models are then applied to the 2001 Census data.

This latter two approaches (Models 2 and 3) produced small area FPI estimates which reflected a different set of factors – or a different weighting of the same factors – according to the characteristics (settlement, GOR) of the spatial unit under consideration. In contrast with Model 1, Models 2 and 3 assume that the predictors of fuel poverty are spatially variable. For example, lack of central heating may have a different 'effect' upon the likelihood of fuel poverty in central London than it does in rural west Cornwall. The assumption of spatial invariance rarely holds in the investigation of social phenomena. In the case of the fuel poverty analysis, there are compelling a priori grounds for supposing that the predictors of fuel poverty – as well as their relative weights – will vary in areas of different types, both with respect to their geography and settlement pattern.

Modelling Results

The results of applying these different modelling strategies to the 2003 EHCS data are described in full in Appendix 1. It is clear from inspection of the model statistics that both of the spatially stratified modelling strategies (Models 2 and 3, above) give rise to slightly better fit statistics (Nagelkerke R square), in comparison with the 'Basic' and 'Full' FPI global models (Model 1). This is so for all versions of Models 2 and 3, with the exceptions of London (Full FPI, Model 2), and 'South East/East/London' (Basic and Full FPI, Model 3). This improved 'fit' is to be expected if, as hypothesised, the predictors of fuel poverty vary spatially in their effects. Nonetheless, the model fit statistics for the two 'global' models are themselves very good for a study of this type. The relatively small improvement in model fit achieved within the stratified models is therefore achieved at the 'cost' of a greater model complexity. Such improvements can only be justified where the stratified models result in a demonstrable improvement to the overall plausibility of the small-area results generated by

[4] *Multicollinearity* describes any strong linear relationship amongst explanatory variables in a regression model resulting in imprecise model estimates. If nominally different variables are in fact highly correlated they are redundant resulting in a danger of the model over-fitting the data. *Heteroskedasticity* refers to unequal variance in regression errors across values of our dependent variable resulting in biased model estimates. See Cook (1982) for further details.

the procedures. Evidence of improved plausibility can be obtained by mapping the results at SOA level and through comparing the results with the published estimates derived from the EHCS at Govt. Office Region (GOR) level.

The results obtained through these competing modelling approaches were compared with the published estimates at GOR level by aggregating the resultant 2001 Census small area FPI indicator to GOR level. The results of this procedure are shown in Tables 3a and 3b (*below*) for Basic Income FPI and Full Income FPI respectively.

Table 3a: Comparison of Model Results with 2003 EHCS Estimates at GOR-level – Basic Income FPI.

GOR	2003 EHCS		Global (Model 1)	Settlement (Model 2)	Super-GOR (Model 3)
	%	*95% CI*	*%*	*%*	*%*
North East	10.8	9.0 - 13.1	7.8	8.2	10.6
Yorkshire & Humber	10.4	9.0 - 12.1	7.6	7.8	10.2
North West	8.4	7.3 - 9.7	7.6	7.6	7.9
East Midlands	6.4	5.2 - 7.9	7.2	7.5	7.5
West Midlands	8.5	7.2 - 10.0	7.3	7.4	7.6
South West	7.0	5.8 - 8.4	6.8	7.2	7.1
East of England	5.1	4.1 - 6.4	6.4	6.7	4.8
South East	5.1	4.1 - 6.1	6.0	6.1	4.5
London	6.0	5.1 - 7.2	6.6	5.1	5.4

Table 3b: Comparison of Model Results with 2003 EHCS Estimates at GOR-level –Full Income FPI.

GOR	2003 EHCS		Global (Model 1)	Settlement (Model 2)	Super-GOR (Model 3)
	%	*95% CI*	*%*	*%*	*%*
North East	8.7	6.9 – 10.9	6.6	6.8	8.7
Yorkshire & Humber	8.6	7.2 – 10.3	6.6	6.8	8.6
North West	6.3	5.2 – 7.6	6.7	6.6	7.1
East Midlands	6.3	5.1 – 7.9	6.5	6.9	6.9
West Midlands	6.7	5.5 – 8.2	6.5	6.6	6.9
South West	6.5	5.3 – 8.0	6.2	6.8	6.8
East of England	5.1	4.0 – 6.4	5.9	6.4	4.6
South East	4.4	3.5 – 5.6	5.7	5.9	4.3
London	3.6	2.7 – 4.7	5.4	3.5	4.2

In interpreting these results it is important to acknowledge that, since the 2003 EHCS results are based upon a sample of approximately 15,000 households, they are an estimate of the underlying population values for the fuel poverty indicator. Hence, if a different but similarly sized sample of households had been surveyed simultaneously it is likely that a different estimate of the 'true' incidence of fuel poverty in the population as a whole at GOR level would have been recorded. This certainly does not mean that the official estimate is 'wrong' but rather that a range of values for the underlying population are equally plausible given that our estimate is based upon a representative sample and not upon a complete enumeration of the population. We can nevertheless get an idea about the certainty (or

precision) of our estimate by calculating a 'confidence interval' for our estimate. This establishes the range of plausible values for the underlying population statistic at a specified level of confidence.

Assuming a simple random sample it is a straightforward task to calculate the range of plausible population values at a range of confidence levels (conventionally the 95% level). However, the 2003 EHCS survey is a complex, clustered multi-stage sample. It was therefore necessary to estimate these parameters by using the SPSS 'Complex Samples' routine. We therefore used a clustered design stratified by sample year, GOR, tenure status, and urban/rural status, as in the 2003 EHCS (and applying the EHCS household weight). Unfortunately, however, for technical and data protection reasons it was not possible to fully replicate the 2003 EHCS multi-stage sample design. The 95% Confidence Intervals quoted in Tables 3a and 3b (*above*) therefore represent a *minimum estimate* of the likely actual range of plausible population values for the Basic and Full Income FPI at GOR level in 2003 at the 95% confidence level.

In most cases our estimates fall within the above confidence intervals for the 2003 EHCS GOR-level estimates and as such are statistically identical with those data. Bearing in mind that the confidence intervals quoted above are only minimum estimates, the only significant divergence in estimates occur with the Basic Income FPI for the North East and Yorkshire and Humberside (Models 1 & 2) and with the Full Income FPI for London (Model 1), the South East (Model 2) and, to a lesser extent, Yorkshire and Humberside (Models 1 & 2). Although this may suggest that Model 3 is preferable, inspection of the resultant maps of results for the Basic and Full Income FPI at Mid-SOA level reveal some intuitively implausible boundary effects that have arisen from the stratification process. These maps are reproduced in full in Appendix 4. It is, for example, implausible that rates of Full Income fuel poverty decline rapidly from relatively high levels in the west of England (*e.g.* Gloucestershire, Somerset) to very low levels on the other side of the GOR boundary (*e.g.* Wiltshire, Berkshire), as detailed within Model 3 (*see Appendix 4*).

This type of effect is clearly an artefact of the spatial stratification strategy employed in modelling these data. The strategy, in effect, fits the same model to all data within a particular region or particular settlement type. However, an effective modelling strategy depends upon a clear understanding of the underlying spatial processes involved. It is likely that these operate at a much finer spatial scale than GOR 'super-region' or settlement type. Although beyond the scope of this project, a range of approaches are available to address this research problem. In particular, Geographically Weighted Regression techniques allow model estimates to vary spatially in relation to a range of user-defined parameters (Fotheringham et al., 2002). The research team therefore recommends that this approach is applied in future up-dates of the small-area FPI methodology.

In the absence of geographically weighted regression techniques, and given the relatively slight (and uneven) improvements in model fit derived from the stratified models, the global models of Basic and Full Income FPI represent the most plausible approach of generating weightings for application to census data. The 'global' approach is both parsimonious and accords with theory and evidence on causes of fuel poverty. The results of the global analyses are presented in Table 4a (Basic Income) and Table 4b (Full Income). The final model variables for the Basic and Full Income FPI are:

Basic Income FPI

- Property value less than £80,000
- NS-Sec of HRP= routine/semi-routine
- Single pensioner hhld
- Single non-pensioner hhld
- Lone parent hhld
- Private rental tenant
- Council tenant
- HRP not in work
- Dwelling built pre-1920
- Hhld lacks central heating
- Respondent has no qualifications
- Low occupancy standard
- One person hhlds with 7+ rooms
- Pre-1920 detached dwelling

Full Income FPI

- Properties valued at less than £80,000
- NS-Sec of HRP= routine/semi-routine
- Single pensioner households
- Single non-pensioner households
- Lone parent households
- Private rental tenants
- HRPs not in work
- Dwellings built pre-1920
- Households lacking central heating
- Respondent with no qualifications
- Low occupancy standard
- One person households with 7+ rooms
- Pre-1920 detached dwellings

Once the 'overlap' between variables is allowed for, the most significant multivariate predictors of fuel poverty are a little different to the individual level predictors shown in Tables 2a and 2b. The overall odds of fuel poverty for each variable included in the model are given in the final column of each table. For example, considering the Basic Income FPI indicator (*below*) (and taking into account the simultaneous effects of these variables upon our dependent variable), single pensioners are twice as likely (1:2.075) to be fuel poor compared with other household types. The statistical significance of the odds estimates can be calculated from the Wald statistic and standard error but all of the variables included in these models are significant at the p<.001 level.

Table 4a: 2003 EHCS Basic Income FPI Final Model. Binary Logistic Regression.

Variable	B	se	Wald	Sig	Odds
Property value less than £80,000	0.633	0.080	62	<.001	1.883
NS-Sec of HRP= routine/semi-routine	0.531	0.083	41	<.001	1.701
Single pensioner hhld	0.730	0.109	45	<.001	2.075
Single non-pensioner hhld	2.351	0.113	430	<.001	10.493
Lone parent hhld	1.846	0.146	159	<.001	6.335
Private rental tenant	0.948	0.123	60	<.001	2.581
Council tenant	0.538	0.100	29	<.001	1.712
HRP not in work	2.535	0.100	636	<.001	12.616
Dwelling built pre-1920	0.653	0.095	47	<.001	1.922
Hhld lacks central heating	0.483	0.049	98	<.001	1.622
Respondent has no qualifications	0.531	0.088	37	<.001	1.700
Low occupancy standard	0.481	0.096	25	<.001	1.618
One person hhlds with 7+ rooms	0.860	0.108	64	<.001	2.362
Pre-1920 detached dwelling	1.396	0.184	58	<.001	4.038
Constant	-6.819	0.160	1810	<.001	0.001
-2LL					*5148*
Chi Sq (df)					*2665(14)*
Nag. Rsq.					*.397*
N					*15927*

Table 4b: 2003 EHCS FULL INCOME FPI Final Model. Binary Logistic Regression.

	B	se	Wald	Sig	Odds
Property value less than £80,000	0.489	0.081	36	<.001	1.630
NS-Sec of HRP= routine/semi-routine	0.374	0.084	20	<.001	1.453
Single pensioner hhld	0.765	0.106	52	<.001	2.149
Single non-pensioner hhld	1.782	0.109	266	<.001	5.940
Lone parent hhld	0.946	0.176	29	<.001	2.576
Private rental tenant	0.554	0.127	19	<.001	1.741
HRP not in work	1.977	0.098	410	<.001	7.224
Dwelling built pre-1920	0.684	0.091	57	<.001	1.982
Hhld lacks central heating	0.583	0.049	144	<.001	1.791
Respondent has no qualifications	0.697	0.089	62	<.001	2.007
Low occupancy standard	0.900	0.106	72	<.001	2.459
One person hhlds with 7+ rooms	0.783	0.104	56	<.001	2.187
Pre-1920 detached dwelling	1.277	0.173	54	<.001	3.588
Constant	-6.470	0.155	1735	<.001	0.002
-2(Log Likelihood)*					*5192*
Chi Sq. (df)					*1996(13)*
Nagelkerke R sq.					*.324*
N					*15921*

The preliminary fuel poverty model derived from the 2003 EHCS needs to be calibrated to the 2001 Census data for England to ensure that the weightings achieve 100% coverage. As the underlying regression equation is additive, the regression coefficients themselves (B) can be re-calibrated and applied directly to the 2001 Census small area statistics. The final weights used in deriving the small area estimates are shown below.

The number of Basic Income FPI poor households is equal to:

1.3% of households living in properties valued at less than £80,000
+ 1.1% of households headed by routine/semi-routine employees
+ 1.4% of single pensioner households
+ 4.7% of single non-pensioner households
+ 3.7% of lone parent households
+ 1.9% of private rental households
+ 1.1% of council tenant households
+ 5.0% of households in which the HRP is not in work
+ 1.3% of households living in pre-WW1 dwellings
+ 1.0% of households lacking central heating
+ 1.1% of households without educational qualifications
+ 1.0% of under-occupied dwellings (based upon occupancy standard)
+ 1.7% of one-person households with 7+ rooms
+ 2.8% of households living in detached pre-WW1 dwellings.

The number of Full Income FPI poor households is equal to:

0.8% of households living in properties valued at less than £80,000
+ 0.6% of households headed by routine/semi-routine employees
+ 1.3% of single pensioner households
+ 3.0% of single non-pensioner households
+ 1.6% of lone parent households
+ 0.9% of private rental households
+ 3.3% of households in which the HRP is not in work
+ 1.2% of households living in pre-WW1 dwellings
+ 1.0% of households lacking central heating

+ 1.2% of households without educational qualifications
+ 1.5% of under-occupied dwellings (based upon occupancy standard)
+ 1.3% of one-person households with 7+ rooms
+ 2.2% of households living in detached pre-WW1 dwellings.

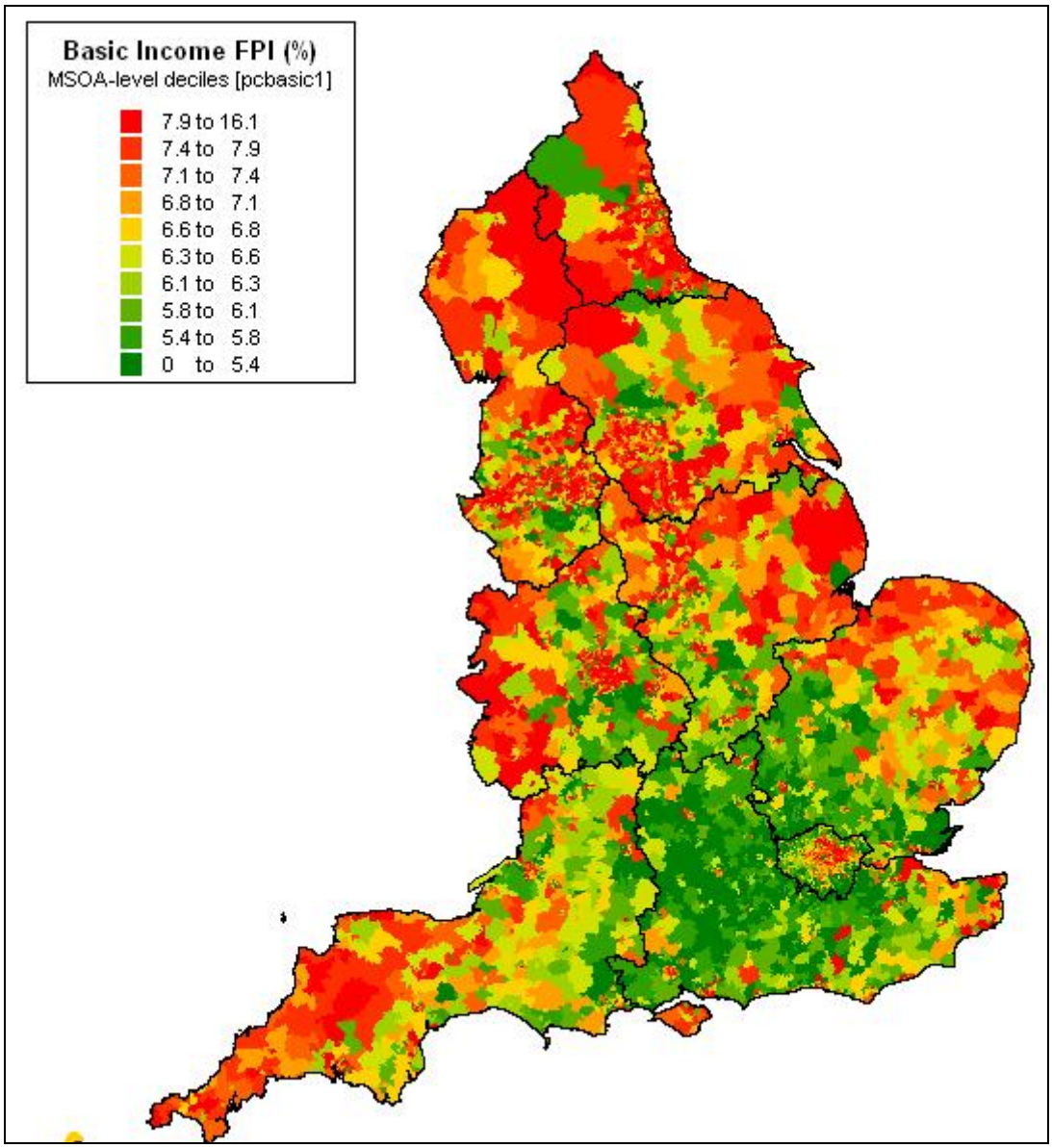
Based upon these empirically derived weights, the distribution of fuel poverty can then be estimated at any spatial scale of census geography (including Output Area) by combining the census and Residata databases. A summary of results for the global models of Basic and Full Income FPI by Government Office Region and settlement type is given in Table 5 (*below*). With respect to settlement type (*as defined above*) these data show the disparity between Basic and Full Income FPI to be greatest in London and other urban areas. With respect to regional differences these data show the disparity between Basic and Full Income FPI to be greatest in the north (North East, North West, Yorkshire and Humberside GORs), as well as the East Midlands and London Govt. Office Regions.

Table 5: Summary Results by Settlement Type and Govt. Office Region – Basic and Full Income FPI (%)

		a) Basic	b) Full	Diff. (b-a)
Settlement type:	London	6.6	5.4	-1.2
	Urban	7.1	6.3	-0.8
	Suburban	6.4	6.0	-0.4
	Rural	6.9	6.6	-0.3
Govt. Office Region:	East Midland	7.2	6.5	-0.8
	East of England	6.4	5.9	-0.5
	London	6.6	5.4	-1.2
	North East	7.8	6.6	-1.2
	North West	7.6	6.7	-0.9
	South East	6.0	5.7	-0.4
	South West	6.8	6.2	-0.6
	West Midlands	7.3	6.5	-0.8
	Yorks & Humber	7.6	6.6	-1.0
TOTAL		***6.9***	***6.1***	***-0.8***

The final results (*overleaf*) show the distribution of the FPI indicator based upon the Basic and Full Income definitions at Mid-Super Output Area level. These data show that for both the Basic and Full Income FPI indicators, fuel poverty is concentrated in urban areas, and especially in the major conurbations (e.g. London, West Midlands, Greater Manchester, North West), as well as in more remote rural areas (e.g. Devon and Cornwall, East Anglia, Cumbria and Durham).

Figure 2a: Basic Income FPI at 2001 Middle Super Output Area Level (%).



Boundary data supplied by UKBORDERS at Edina

Figure 2b: Full Income FPI at 2001 Middle Super Output Area Level (%).

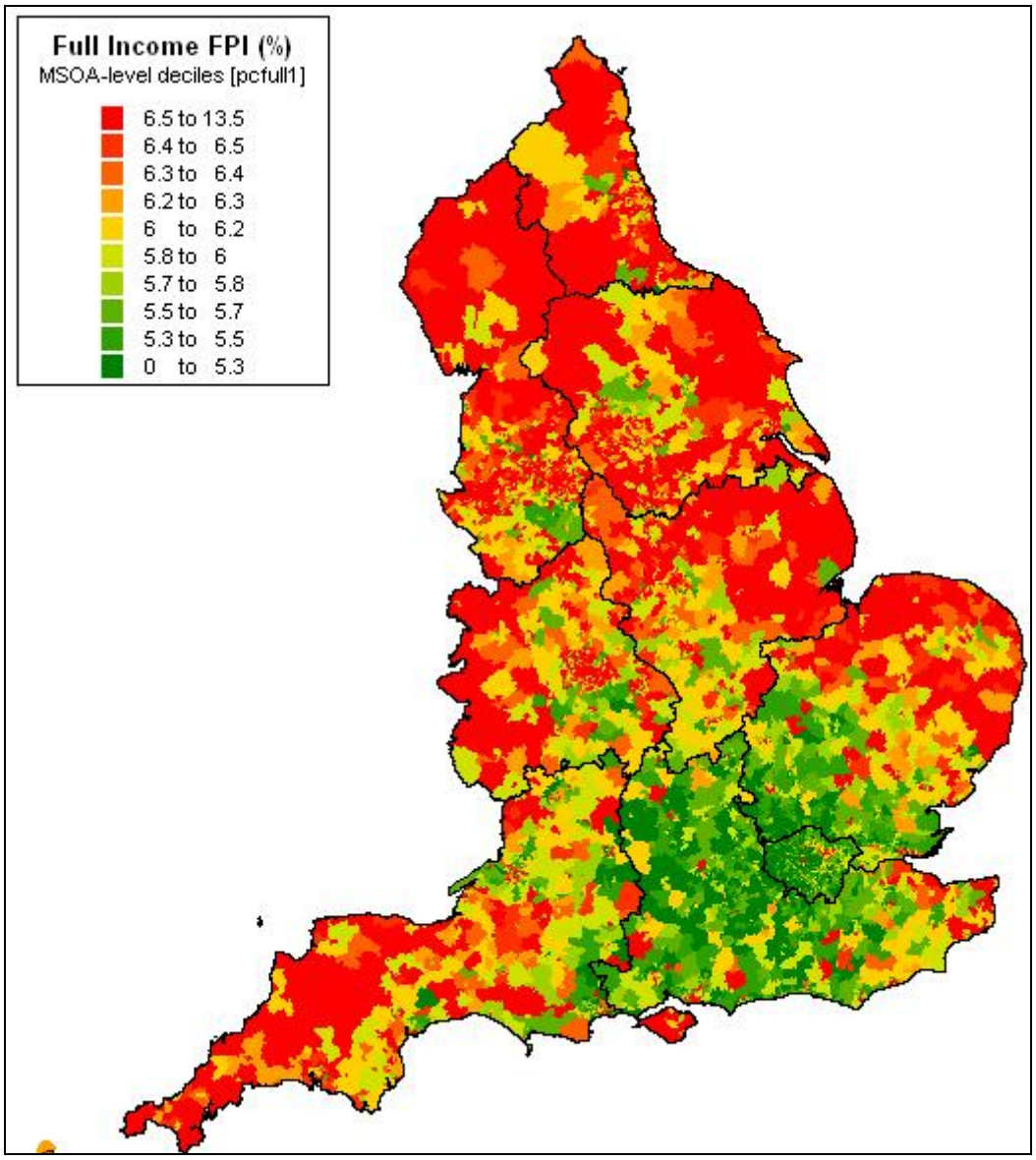


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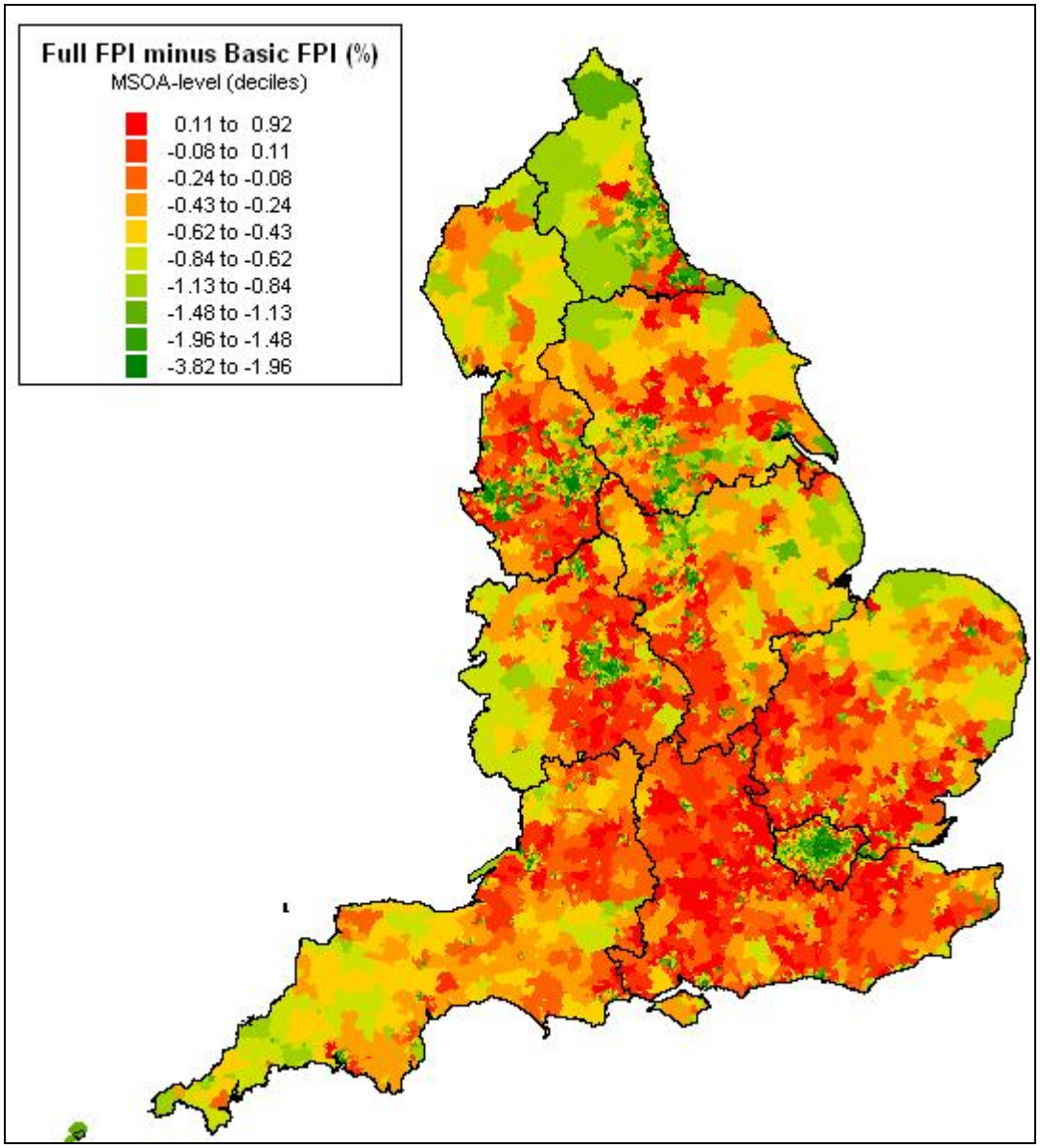
Figure 2c: Change in FPI at 2001 Middle Super Output Area Level – Basic to Full Income FPI (%).



Boundary data supplied by UKBORDERS at Edina

1.10 Summary of Findings

In comparison with the original Fuel Poverty Indicator based upon 1991 Census data and the 1996 EHCS, the revised 2003 Fuel Poverty Indicator takes advantage of a variety of scientific and technical advances in data sources. Specifically, these relate to changes in the output geography of census analysis, improvements in census topic coverage and linkage to postcoded data sources (notably Residata), and similar improvements in the energy use modelling and income measurement methodology associated with the 2003/04 EHCS dataset (*see Section 1.1*). The process of data harmonisation and matching is complex, and is described in detail in Sections 1.4 to 1.6. The modelling of these data has also been informed by advanced Exhaustive CHAID techniques in order to identify optimal splits in the categorical predictor variables pertinent to this study, as described in Section 1.7.

The initial, univariate associations between the various social and demographic characteristics of the EHCS sample and fuel poverty status are described in Section 1.8. These indicate that the following risk factors are all associated with an elevated risk of fuel poverty as measured by the Full Income FPI: low dwelling valuation; pre-1920 dwelling construction; low social class status (NS-Sec); single person or lone parent household status; low educational attainment; lack of central heating; unemployment and economic activity, and; rental (especially local authority) accommodation. However, estimating the relative weight of these 'risk markers' as predictors of fuel poverty in the real world requires a multivariate logistic regression analysis in order to model their simultaneous effects. A variety of approaches to modelling these data using multivariate techniques are therefore outlined in Section 1.9.

In developing these models it has been assumed that the predictors of fuel poverty as well as their weights may vary spatially so that a lack of central heating may have a different 'effect' upon the odds of fuel poverty in central London than in rural west Cornwall. However, an effective spatial modelling strategy depends upon a clear understanding of the underlying processes involved and it is likely that these operate at a much finer spatial scale than was available within the scope of this project. In fact, as Section 1.9 explains, the most parsimonious solution is also the most compelling with regard to its fit with existing theory and evidence on causes of fuel poverty – namely, the 'global' models of Basic and Full Income fuel poverty as detailed in Tables 6a and 6b. On this basis the number of Full Income FPI poor households is equal to:

0.8% of households living in properties valued at less than £80,000
+ 0.6% of households headed by routine/semi-routine employees
+ 1.3% of single pensioner households
+ 3.0% of single non-pensioner households
+ 1.6% of lone parent households
+ 0.9% of private rental households
+ 3.3% of households in which the HRP is not in work
+ 1.2% of households living in pre-WW1 dwellings
+ 1.0% of households lacking central heating
+ 1.2% of households without educational qualifications
+ 1.5% of under-occupied dwellings (based upon occupancy standard)
+ 1.3% of one-person households with 7+ rooms
+ 2.2% of households living in detached pre-WW1 dwellings

Preliminary mapping of these results at Mid-Super Output Area level reveals fuel poverty to be concentrated in urban areas, and especially in the major conurbations (e.g. London, West Midlands, Greater Manchester, North West), as well as in more remote rural areas (e.g. Devon and Cornwall, East Anglia, Cumbria and Durham), as detailed in Figures 1a and 1b. Further visualisation of these data will be undertaken as part of the dissemination phase associated with this project.

Section 2: Different Treatments of Income and Fuel Poverty

2.1 The EHCS Income Model

The EHCS is designed to accurately measure housing conditions but it is not primarily designed to produce the most accurate possible estimates of household income. Nevertheless, the income measurement in the EHCS is as good as or better than many other Government surveys and considerably better than most market research surveys. However, due to the logistical infeasibility of collecting all components of household income in a survey like the EHCS, a sophisticated income model was produced to impute missing income components and adjust some of the income measures so that they are more comparable with other national income survey data (e.g. *Family Resources Survey* and the *Expenditure and Food Survey*). However, this income model which is sometimes called the '2001 model' (DCLA, 2006), deviates from the income measures used in most other government survey in two important respects:

1) The income is not adjusted (equivalised) for different household compositions and sizes
2) It is assumed that all reported household incomes less than the Income Support threshold have been miss-reported and are incorrect and these incomes are then adjusted so as to increase them either to or above the income support threshold level (BRE, 2005).

This section explores how the rate and geography of fuel poverty would change if: a) household incomes were equivalised, and; b) if income were equivalised and those households with very low incomes were assumed to have reported their incomes correctly. These two changes to the 2001 EHCS Income Model make the household income results more comparable with household income as measured by the *Family Resources Survey* and *Expenditure and Food Survey*.

2.2 The Definition of Income

Income is a key concept in almost all definitions and studies of poverty (Spicker, Alvarez & Gordon, 2007), including all definitions of fuel poverty. However, 'income' is an extremely difficult concept to define and agree upon. The term is sometimes used loosely to refer only to the main component of monetary income for most households – *i.e.* wages and salaries or business income. Others use the term more widely to include all receipts including lump sum receipts and receipts that draw on the household's capital. Much of the debate has centred on whether:

- income should include only receipts that are recurrent (that is, exclude large and unexpected, typically one-time, receipts);
- income should only include those components which contribute to current economic well-being, or extend also to those which contribute to future well-being;
- whether the measure of income should allow for the maintenance of the value of net worth. (Canberra Group, 2001)

Classically, income has been defined as the sum of consumption and change in net worth (wealth) in a period. This is known as the *Haig-Simons approach* (see Simons, 1938 in

Atkinson & Stiglitz, 1980: 260). Unfortunately, this approach fails to distinguish between the day-to-day 'living well' and the broader 'getting rich' aspects of individual or household finances (in technical terms, it fails to distinguish between current and capital receipts).

There are a number of international organisations that have provided guidelines on defining and measuring income. The United Nations provides two frameworks: the 1993 System of National Accounts (UN, 1992) and guidelines on collecting micro-level data on the economic resources of households (UN: 1977, 1989). The International Labour Organisation (ILO) has also produced guidelines on the collection of data on income of households, with particular emphasis on income from employment (ILO: 1971, 1992, 1993). In 1997, the Australian Bureau of Statistics (ABS) tried to get an international agreement on definitions of income, consumption, saving and wealth. The ABS (1995) has proposed the following definition:

> *Income comprises those receipts accruing (in cash and in-kind) that are of a regular and recurring nature, and are received by the household or its members at annual or more frequent intervals. It includes regular receipts from employment own business and from the lending of assets. It also includes transfer income from government, private institutions and other households. Income also includes the value of services provided from within the household via the use of an owner-occupied dwelling, other consumer durables owned by the household and unpaid household work. Income excludes capital receipts that are considered to be an addition to stocks, and receipts derived from the running down of assets or from the incurrence of a liability. It also excludes intra-household transfers.*
>
> (See http://lisweb.ceps.lu/links/canbaccess.htm for more details)

This initiative by the ABS led to the establishment of the United Nations Expert Group on Household Income Statistics (Canberra Group) which issued a series of recommendations on the definitions and components of household income in its final report[5] in 2001 (*see Table 6*).

[5] See http://www.lisproject.org/links/canberra/finalreport.pdf

Table 6: Definitions of Income - Canberra Group Recommendations

1 Employee income
Cash or near cash
1.1 Cash wages and salaries
1.2 Tips and bonuses
1.3 Profit sharing including stock options
1.4 Severance and termination pay
1.5 Allowances payable for working in remote locations etc, where part of conditions of employment

Cash value of 'fringe benefits'
1.6 Employers' social insurance contributions
1.7 Goods and services provided to employee as part of employment package

2 Income from self-employment
Cash or near cash
2.1 Profit/loss from unincorporated enterprise
2.2 Royalties

In-kind, imputed
2.3 Goods and services produced for barter, less cost of inputs
2.4 Goods produced for home consumption, less cost of inputs
2.5 Income less expenses from owner-occupied dwellings

3 Rentals
3.1 Income less expenses from rentals, except rent of land

4 Property income
4.1 Interest received less interest paid
4.2 Dividends
4.3 Rent from land

5 Current transfers received
5.1 Social insurance benefits from employers' schemes
5.2 Social insurance benefits in cash from government schemes
5.3 Universal social assistance benefits in cash from government
5.4 Means-tested social assistance benefits in cash from government
5.5 Regular inter-household cash transfers received
5.6 Regular support received from non-profit making institutions such as charities

6 *Total income (sum of 1 to 5)*

7 Current transfers paid
7.1 Employers' social insurance contributions
7.2 Employees' social insurance contributions
7.3 Taxes on income
7.4 Regular taxes on wealth
7.5 Regular inter-household cash transfers
7.6 Regular cash transfers to charities

8 *Disposable income* *(6 less 7)*

9 Social transfers in kind (STIK) received

10 *Adjusted disposable income* *(8 plus 9)*

Townsend (1979; 1993) has argued that broad definitions of income should be used, particularly if international comparisons are to be made. It is crucial, when comparing individual or household incomes of people in different countries, that account is taken of the value of government services in, for example, the fields of health, education and transport (Evandrou *et al*, 1992). Unfortunately, attempts in Britain to measure income and wealth using broad definitions of these concepts have often ended in failure (Knight, 1980).

2.3 Income Definitions Used in Fuel Poverty Studies

The extent and depth of fuel poverty is dependent on both the definitions used of both income and heating regime. An agreed definition of fuel poverty is essential so that the extent of the problem can be estimated, and progress on tackling it can be monitored. It has now been agreed to use two definitions of fuel poverty in England and Wales (DEFRA & DTI, 2001):

i) Definition To Be Focussed On For Target Setting
A household is in fuel poverty if, in order to maintain a satisfactory heating regime, it would be required to spend more than 10% of its income (including Housing Benefit or Income Support for Mortgage Interest (ISMI)) on all household fuel use. This is sometimes called 'Full Income'.

ii) Additional Definition
A household is in fuel poverty if, in order to maintain a satisfactory heating regime, it would be required to spend more than 10% of its income (not including Housing Benefit or Income Support for Mortgage Interest ISMI) on all household fuel use. This is sometimes called 'Basic Income'.

The UK Government's official analysis of low income is published annually in the *Households Below Average Income* (HBAI) statistics which provide estimates of patterns of personal disposable income in Great Britain, and of changes in income over time in the United Kingdom. The HBAI statistics concentrate on the lower part of the income distribution, but provide comparisons with the upper part where appropriate. Income in HBAI refers to disposable household income: that is income (from earnings, self employment, benefits, occupational pensions, investments and other flows) after the deduction of income tax, National Insurance contributions, local government taxes and certain other deductions. Each person's income is aggregated across the household and adjusted to reflect the composition of the household. This process is known as equivalisation and reflects the relative needs of households of varying size and composition (Frosztega, 2000). HBAI presents income analyses on two bases: Before Housing Costs (BHC) and After Housing Costs (AHC).

Income Before Housing Costs (BHC) includes the following main components:

- Usual net earnings from employment;
- Profit or loss from self-employment (losses are treated as a negative income);
- All social security benefits (including housing benefit, social fund, maternity, funeral and community care grants but excluding social fund loans) and tax credits;
- Income from occupational and private pensions;
- Investment income;
- Maintenance payments, if a person receives them directly;

- Income from educational grants and scholarships (including, for students, top up loans and parental contributions);
- The cash value of certain forms of income in kind (free school meals, free welfare milk, free school milk and free tv licence for those 75 and over).

Income is net of the following items:

- Income tax payments;
- National insurance contributions;
- Domestic rates / council tax;
- Contributions to occupational pension schemes (including all additional voluntary contributions (avcs) to occupational pension schemes, and any contributions to personal pensions);
- All maintenance and child support payments, which are deducted from the income of the person making the payment;
- Parental contributions to students living away from home.

Income After Housing Costs *(AHC)* is derived by deducting a measure of *housing costs* from the above income measure (DWP, 2003). Housing costs include the following:

- Rent (gross of housing benefit);
- Water rates, community water charges and council water charges;
- Mortgage interest payments (net of tax relief);
- Structural insurance premiums (for owner occupiers);
- Ground rent and service charges.

The fuel poverty 'target setting' measure, which includes all benefits received, approximates to the before housing costs definition used in *Households Below Average Income* (HBAI) statistics. The after housing costs definition of income used in HBAI is net of all housing costs. The fuel poverty 'additional definition', which excludes only those housing costs met by Housing Benefit or ISMI, is not consistent with the income measures used by either the Office for National Statistics (ONS) or the Department for Work and Pensions (DWP) for wider analysis of low income. The purpose of this work is to adjust the 'full' and 'basic' incomes in the EHCS so that they become more comparable with the HBAI Before Housing Costs household income measure.

2.4 Equivalisation of Income

Both international and UK standards are clear that when comparing incomes of households of different sizes (numbers of people) income should be equivalised – adjusted for household size and composition. For example, the final report of the United Nations Expert Group on Household Income Measurement (Canberra Group) recommended "*that income should be adjusted to take account of household size, using equivalence scales.*"

Both the DWP and the European Union have now agreed that low income/poverty statistics should be equivalised using the Modified OECD Scale (Atkinson *et al*, 2002; DWP, 2003). Income used to calculate fuel poverty can also be adjusted using this scale. For example, a family of 4 with an annual income of £15,000 can be considered to be 'poorer' than a single person with an annual income of £15,000. If both these families live in a 1930's semi-detached house the heating and fuel costs of the family of four will be slightly greater than for the single person. However, some of the family of fours non-fuel costs will be much

greater (*e.g.* their food costs, their clothing costs, etc.) - these costs have greater elasticity than fuel costs. Unless income is equivalised to take account of these additional costs then any fuel poverty calculation will inevitably underestimate the 'true' amount of fuel poverty amongst larger households and overestimate the extent of fuel poverty amongst smaller households. This will result in a overestimate of the extent of fuel poverty in areas with high proportions of small households and an underestimate of the extent of fuel poverty in areas with high proportions of large households.

To examine the geographic effects of income equivalisation on fuel poverty, both Full and Basic Income were equivalised using the modified OECD scale which was rescaled so that a two person household was the base comparison unit (rather than a one person household). This rescaling does not affect the validity of the equivalisation but it makes comparisons with EHCS fuel poverty simpler[6].

Equivalisation of income results in a slight fall in the 2003 national fuel poverty rates from 6.9 per cent to 6.1 per cent for Basic Income, and from 6.1 per cent to 5.0 per cent for Full income. Similar results were reported by Richard Moore after income equivalisation using older data. Tables 7a and 7b show how the risk of being fuel poor changes for different socio-economic and demographic groups when income is equivalised. The first column of Table 7a shows the risk of fuel poverty for equivalised Basic Income and the second column shows the risk for un-equivalised Basic Income. Table 7b shows similar results for equivalised and un-equivalised Full Income.

It is clear that for both Basic and Full Income, equivalisation results in an increased risk of fuel poverty for families with children and overcrowded households and a reduced risk of fuel poverty for single person households and under-occupied households. At the individual level, the most significant change is that more children and fewer pensioners are classified as fuel poor as a result of equivalisation of income.

[6] The Modified OECD equivalisation scale is 1.00 FIRST ADULT, 0.5 OTHER ADULTS (aged 14+ years), 0.3 CHILDREN UNDER 14. In this work this scale has been multiplied by (1/1.5) to facilitate comparisons with the EHCS fuel poverty results.

Table 7a: Odds of Basic Income Fuel Poverty - Equivalised and Un-equivalised Income Data – Univariate Statistics

	VARIABLE	Equivalised Basic Risk	Basic Risk
Property value	Less than £40,000	3.6	3.9
	£40,001 to £60,000	1.8	2.0
	£60,001 to £80,000	1.6	1.5
	£80,001 to £100,000	0.7	0.7
	£100,001 to £120,000	0.7	0.5
	£120,001 to £200,000	0.6	0.6
	£200,001 to £500,000	0.4	0.5
	More than £500,000	[0.7]	0.5
NS-Sec (HRP)	Higher prof./managerial	0.2	0.2
	Lower prof./managerial	0.3	0.3
	Intermediate	0.6	[1.0]
	Small employers/own account	[1.0]	[0.9]
	Lower supervisory/technical	[0.9]	[1.1]
	Semi-routine	2.2	2.0
	Routine	2.7	2.4
	Other	**6.4**	**[1.9]**
Household composition	**Single pensioner**	**0.4**	**3.3**
	Single person	**1.5**	**3.2**
	All pensioners	0.6	0.6
	Couple, no dep. children	0.4	0.3
	Couple with dep. children	**1.4**	**0.1**
	Lone parent	**3.6**	**2.1**
	Other household	**0.8**	**0.3**
Housing tenure	Owner	0.3	0.1
	Owns with mortgage	0.4	0.8
	Private renter	2.7	1.8
	LA renter	3.4	2.9
	RSL renter	2.0	1.9
Employment status (HRP)	In work (HRP)	0.2	0.1
	Unemployed (HRP)	**21.8**	**11.8**
	Student	**9.8**	**3.2**
	Inactive	**1.6**	**4.5**
Hhld shares accommodation		[1.7]	[5.6]
Hhld shares facilities		[2.2]	[6.8]
Hhld no central heating		3.2	3.9
Limiting long-term illness		**1.7**	**3.2**
Dwelling type	Detached	0.6	0.7
	Semi-detached	[0.9]	0.8
	Terrace	1.5	1.3
	Flat	[1.0]	1.4
	Part/other	1.4	1.7
Year Dwelling Built	Up to 1850	[1.0]	[1.1]
	1851 to 1899	2.0	1.6

	1900 to 1919	1.8	1.6
	1920 to 1944	[0.9]	[1.0]
	1945 to 1964	1.3	1.4
	1965 to 1974	[0.8]	0.8
	1975 to 1980	0.7	[0.8]
	1981 to 1990	0.2	0.3
	1991 to 2006	0.2	0.2
Number of rooms	Up to 2	[1.4]	[1.7]
	3	[0.9]	1.3
	4	1.1	1.2
	5	[0.9]	[0.9]
	6	[0.8]	0.8
	7	1.3	1.3
	8 or more	0.9	0.7
Highest Floor	Basement	1.6	[1.0]
	Ground	0.8	0.7
	First	[1.0]	1.4
	Second	[0.8]	[1.2]
	Third	1.9	[1.4]
	Fourth or higher	3.6	3.5
Occupancy rating	**Occupancy +2**	**0.6**	**[1.1]**
	Occupancy +1	0.8	[0.9]
	Occupancy 0	1.7	[1.1]
	Occupancy -1	**3.3**	**0.3**
	Occupancy -2	**5.6**	**[0.3]**
Educational attainment (resp.)	No qualifications	1.9	3.2
	Level 1	[1.0]	0.8
	Level 2	0.8	0.7
	Level 4/5	0.3	0.2
	Other qual/missing	[0.9]	0.8

Table 7b: Odds of Full Income Fuel Poverty - Equivalised and Un-equivalised Income Data – Univariate Statistics

VARIABLE		Equivalised Full Income	Full Income
Property value	Less than £40,000	1.9	2.6
	£40,001 to £60,000	1.4	1.8
	£60,001 to £80,000	1.6	1.5
	£80,001 to £100,000	0.8	0.7
	£100,001 to £120,000	0.7	0.6
	£120,001 to £200,000	0.7	0.7
	£200,001 to £500,000	0.7	0.6
	More than £500,000	[1.1]	[0.8]
NS-Sec (HRP)	Higher prof./managerial	0.3	0.2
	Lower prof./managerial	0.3	0.4
	Intermediate	[0.8]	[1.2]
	Small employers/own account	1.4	[1.1]
	Lower supervisory/technical	[1.0]	[1.0]
	Semi-routine	1.7	1.8
	Routine	2.0	1.9
	Other	**4.4**	**[1.0]**
Household composition	**Single pensioner**	**0.6**	**4.4**
	Single person	**[0.8]**	**2.5**
	All pensioners	[1.1]	[0.8]
	Couple, no dep. children	0.5	0.4
	Couple with dep. children	**1.8**	**0.2**
	Lone parent	**1.6**	**[0.9]**
	Other household	**[1.0]**	**0.3**
Housing tenure	Owner	0.4	0.2
	Owns with mortgage	[1.0]	1.9
	Private renter	2.3	1.4
	LA renter	1.4	1.3
	RSL renter	[0.8]	0.6
Employment status (HRP)	In work (HRP)	0.3	0.1
	Unemployed (HRP)	7.6	6.4
	Student	**12.5**	**3.0**
	Inactive	**1.5**	**4.7**
Hhld shares accommodation		[1.3]	5.6
Hhld shares facilities		1.2	7.7
Hhld no central heating		3.5	4.4
Limiting long-term illness		1.4	2.9
Dwelling type	Detached	[0.9]	[1.0]
	Semi-detached	[1.2]	[0.9]
	Terrace	1.3	1.3
	Flat	0.4	0.7
	Part/other	[1.1]	1.5
Year Dwelling Built	Up to 1850	1.5	[1.2]
	1851 to 1899	2.2	1.8
	1900 to 1919	2.1	1.8
	1920 to 1944	[1.1]	[1.2]
	1945 to 1964	[1.0]	1.3

	1965 to 1974	0.6	0.6
	1975 to 1980	0.6	0.7
	1981 to 1990	0.1	0.2
	1991 to 2006	0.1	0.2
Number of rooms	Up to 2	[0.5]	[0.9]
	3	0.6	[1.1]
	4	[1.0]	[1.1]
	5	[0.9]	[1.0]
	6	0.7	0.8
	7	1.5	1.5
	8 or more	**1.4**	**0.8**
Highest Floor	Basement	1.9	[1.0]
	Ground	1.3	[1.1]
	First	0.5	[0.8]
	Second	0.5	[0.7]
	Third	[0.7]	[1.0]
	Fourth or higher	1.6	2.4
Occupancy rating	**Occupancy +2**	**0.8**	**1.6**
	Occupancy +1	[0.9]	[0.9]
	Occupancy 0	[1.1]	0.6
	Occupancy -1	**3.2**	**0.1**
	Occupancy -2	**7.0**	**[0.3]**
Educational attainment	**No qualifications**	**1.8**	**3.4**
	Level 1	[1.0]	0.6
	Level 2	[1.0]	0.7
	Level 4/5	0.4	0.3
	Other qualifications/missing	[0.9]	[0.8]

Tables 7a and 7b show the effects of income equivalisation on the risk of being fuel poor for different groups of households. Figures 3a and 3b (*below*) show how these changes in the risk of being fuel poor would affect the geography of fuel poverty – the multivariate model results used to produce these maps are not reported here but are available from the authors.

The most significant changes for both Full and Basic income are that there is relatively greater fuel poverty in the major cities and less fuel poverty in the rural areas close to cites. Figure 2b shows that for equivalising full income results in a significant increase in fuel poverty in east and central London and also in remote rural areas (e.g. Cornwall).

Figure 3a: Equivalised Basic Income FPI at 2001 Middle Super Output Area Level (%).

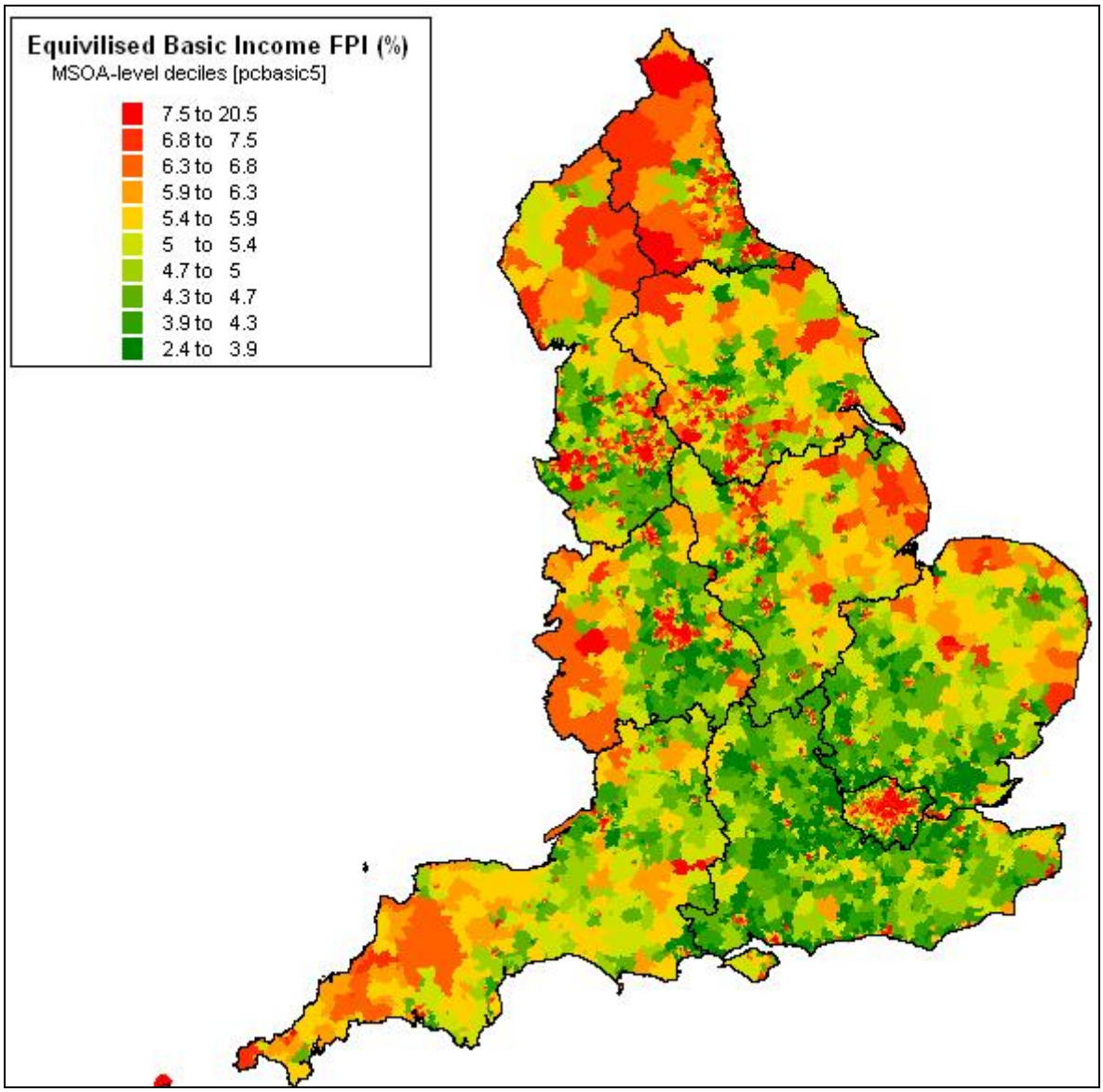
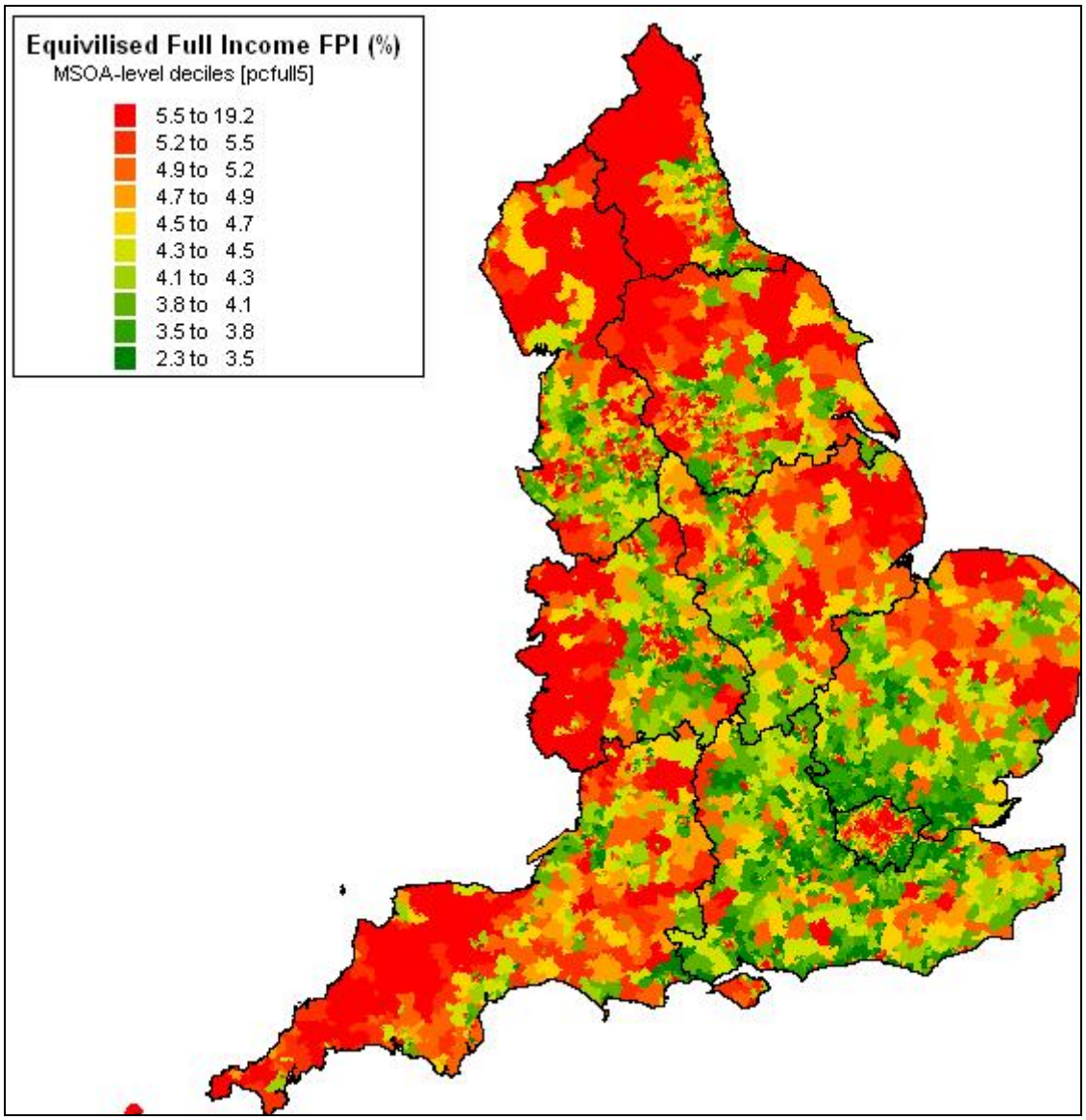


Figure 3b: Equivalised Full Income FPI at 2001 Middle Super Output Area Level (%).



2.5 Imputing Low Income Households

In the 2001 EHCS Income Model "*where household income is less than the minimum, defined as basic income support, it is changed. Where the household receives any of the main state benefits (excluding child benefit) their income is pegged to the basic IS amount (plus any disability premiums if they qualify). Where they don't receive any state benefits then it is assumed that some component of their income is missing.*" (BRE 2005). This second group has their household income imputed (changed) based on the incomes of similar households in the EHCS sample matched on the basis of employment status and SEG of both the Household Reference Person and their partner. Basically, the low income of these types of household is removed and a higher income substituted.

Figures 4 and 5 show the distribution of incomes of very low income households (i.e. with incomes under £5,000 per year) as recorded in the 2003 EHCS (after the 2001 income model

has been applied) and in the 2002/03 *Family Resources Survey*. It is clear that the 2001 ECHS imputation results in no households with incomes below £2,000 pounds per year.

Hot deck imputation using *Family Resources Survey* data was used to re-impute the incomes of the low income households which had had their income increased in the EHCS by the 2001 Income Model. The higher incomes of these households were changed to the lower income of a similar types of household (based on region, SEG and employment status) in the *Family Resources Survey*. If there was more than one matched very low income household in the FRS dataset then the income was selected from amongst these households randomly. Basically, the effects of the low income imputation in the 2001 Income Model were reversed and the imputed 'higher' income was removed and a 'lower' income substituted.

2.6 Do Some Households Really Survive On Very Low Incomes?

The 2001 EHCS income model makes what seems to be a very reasonable assumption, that households cannot live on very low incomes and therefore the reports of these low incomes in the survey are likely to be mistaken. Unfortunately, there is now a considerable body of evidence that many people (millions) have incomes below (and sometimes considerably below the income support standard).

The introduction of Supplementary Benefits in 1966, which replaced the older National Assistance system, was at the time widely believed to have "*dramatically cut the number of poor, eligible for, but not receiving, benefit.*" (Field, 1975). However, Atkinson's (1969) research showed that the increase in benefit take up had been much lower than expected. Analyses of the 1972 *Family Expenditure Survey* by the Department of Health and Social Security (DHSS) showed that 1.78 million people were living on incomes below the Supplementary Benefit level in November 1972 (Source: Correspondence from the DHSS to Brian Sedgemore MP, 13 May 1974 – quoted in Field, 1975).

Figure 4: EHCS 2003 Net Household Income Distribution (£0 to £5,000)

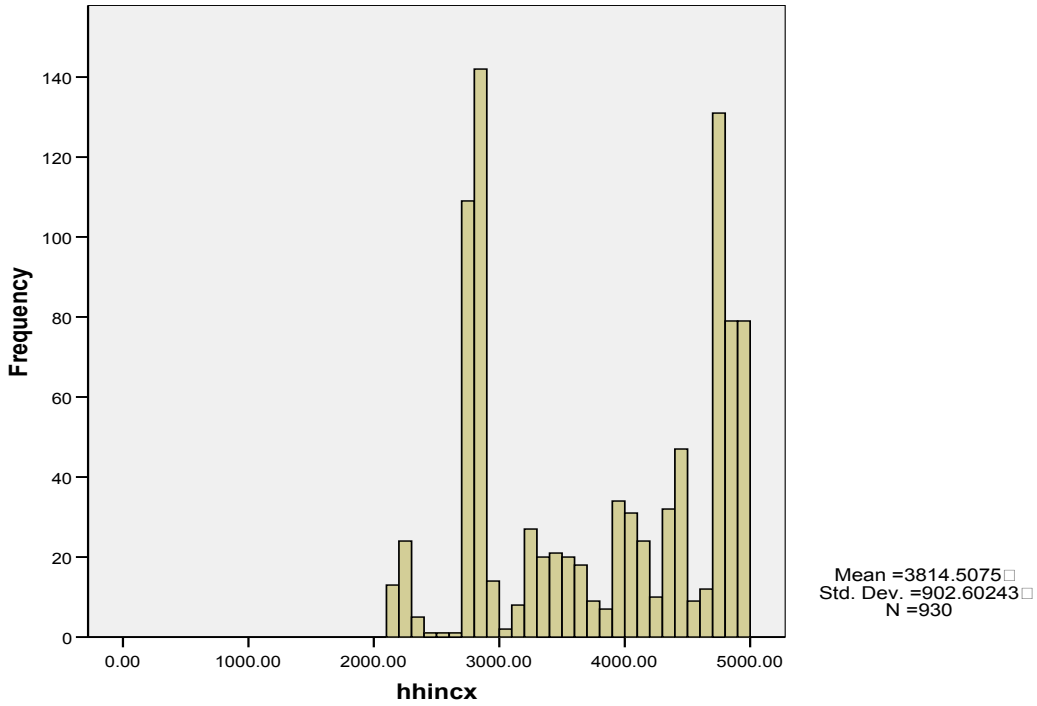
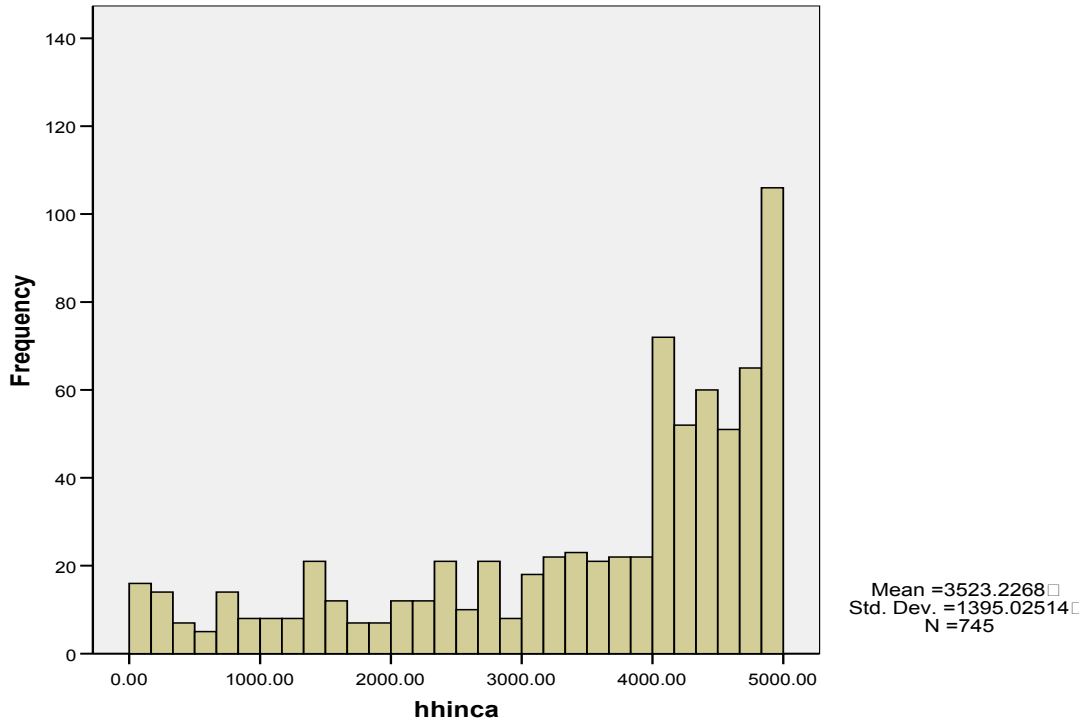


Figure 5: FRS 2001/02 Total Household Income Distribution (£0 to £5,000)

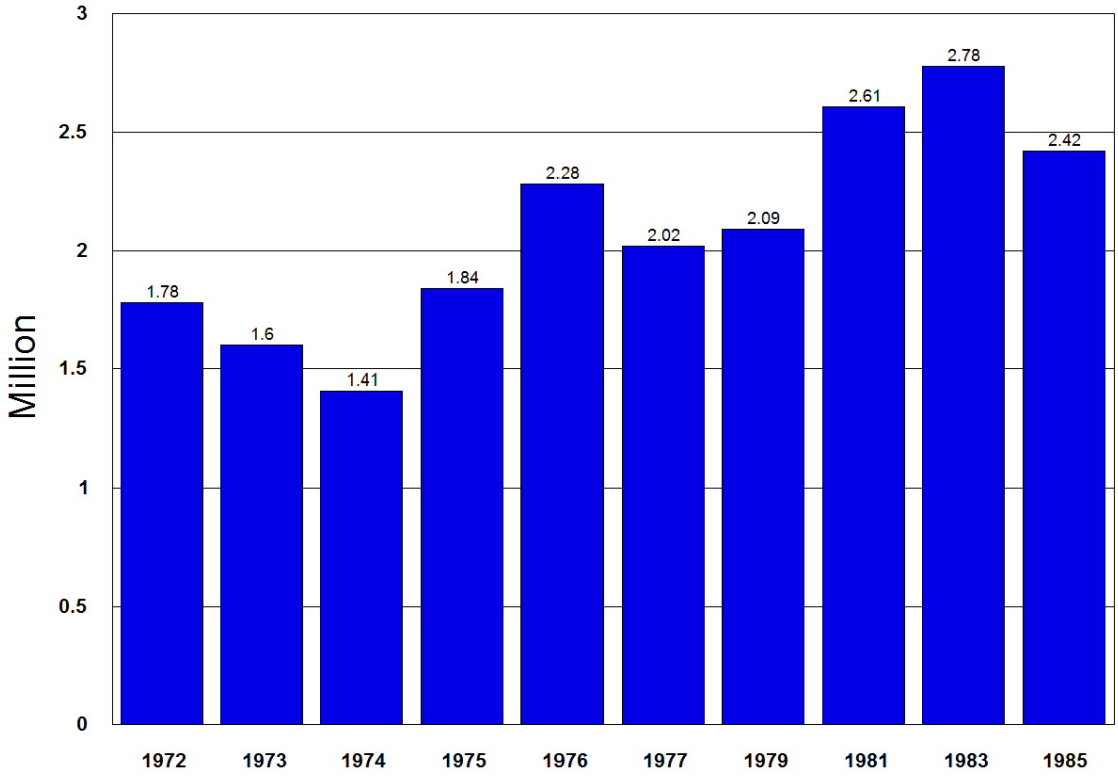


The research on the *Family Expenditure Survey* (FES) by the DHSS resulted in the publication of a new statistical statistics on *Low Income Families* (LIF) which continued until

1988 when it was replaced by the *Households Below Average Incomes* statistical series (DHSS, 1988). The Social Security Committee of the House of Commons commissioned the Institute of Fiscal Studies to continue the LIF series up to 1989 (Social Security Committee, 1992). Amongst other statistics the LIF reported the number of families and people with incomes below the Supplementary Benefits/Income Support standard.

Figure 5 shows the number of people between 1972 and 1985 who had incomes below the Supplementary Benefits standard. In 1972 there were fewer than 2 million people with incomes below the Supplementary Benefit standard, but by 1985 the numbers had increased to almost 2.5 million people (Social Services Committee, 1988).

Figure 6: Number of People in Britain with Incomes Below the SB/IS Standard



Similar, but even higher estimates are available from academic studies, which found that in 1979 there were just over 2 million families and 3 million people with incomes (after the deduction of housing costs) below the SB/IS standard and who were not receiving these benefits. By 1989 the numbers had increased to almost 3 million families and over 4 million people (Giles and Webb, 1993).

In 1990, the House of Commons Social Services Committee found that 3.9 million families and 5.7 million people (e.g. more than one in ten people) had incomes below the new Income Support Standard (Income Support replaced Supplementary Benefits in April 1988). The committee found a wide range of reasons for these high rates of very low incomes, including an estimated 660,000 with capital above the benefit threshold and therefore ineligible for benefit, 280,000 self-employed people who were ineligible to receive benefits, and 830,000 people who may be eligible but had not claimed benefits (Social Services Committee, 1990 – see also Johnson and Webb, 1990).

More recently, the Department for Work and Pensions has carried out some in-depth research into the circumstances of 'minimal income households'. The research consisted of 17 in-depth interviews and a follow-up survey of 165 households with minimal incomes. These were identified from 1994/95 *Family Resource Survey* as having less than £40 per week after housing costs (Elam, Lee & Tadd, 1999). The results demonstrated that in most cases the reported very low incomes were correct and that these 'minimal income households' adopted a wide range of strategies to survive.

This brief review of the relevant literature confirms that many British households have incomes which are below the Income Support standard. These minimal income households have been found in income surveys undertaken in the UK since the early 1970's, but they have probably always existed even prior to the availability of high quality household income data. A primary reason for these very low incomes are that the Welfare State does not now (and never has) provide a minimum income guarantee for all. The UK Welfare State only provides benefits (e.g. Income Support, Supplementary Benefits, etc.) to those people who are entitled to them and who claim these benefits. Many people (literally millions) either are not entitled to these benefits or do not claim them even if they are entitled to them. Hence the persistence of so many minimal income households.

Therefore the models below provide estimates of the extent and geography of fuel poverty after equivalisation of income and assuming that very low incomes have been reported correctly.

2.7 Model Results

The first models were fitted using backward stepwise logistic regression (as described previously) in which all parameters were entered in one block. Following statistical checks the significant variables were then re-entered in as a block into the logistic regression model.

The results of the logistic regression analyses are presented in Table 8a (Equivalised Basic Income with low income households) and Table 8b (Equivalised Full Income with low income households). For convenience the Equivalised Basic Income with low income household model will be referred to as Basic Income HBAI FPI. Similarly the Equivalised Full Income with low income household model will be referred to as Full Income HBAI FPI. It should be noted that neither income model is entirely comparable with HBAI income as calculated from the *Family Resources Survey*.

The final model variables for the Basic and Full Income HBAI FPI are given below. Once the 'overlap' between variables is allowed for (e.g. you can be both a lone parent and live in a pre-1920 dwelling), the most significant multivariate predictors of HBAI fuel poverty are little different to the individual level predictors shown in Tables 7a and 7a. Similarly, most of the variables that are important predictors of fuel poverty using the standard definitions of Basic and Full incomes are also important when using equivalised income and including very low income households (HBAI income).

Basic Income HBAI FPI

- Property value less than £80,000
- NS-Sec of HRP= routine/semi-routine
- Couple with 2+ dependent children
- Lone parent hhld
- Private rental tenant
- Council tenant
- HRP not in work
- Dwelling built pre-1920
- Hhld lacks central heating
- Overcrowded household
- Pre-1920 detached dwelling

Full Income HBAI FPI

- Properties valued at less than £80,000
- NS-Sec of HRP= routine/semi-routine
- Couple with 2+ dependent children
- Lone parent households
- Private rental tenants
- HRPs not in work
- Dwellings built pre-1920
- One person hhlds with 7+ rooms
- Households lacking central heating
- Respondent with no qualifications
- Overcrowded household
- Pre-1920 detached dwellings

The main differences are that couple households with two or more dependent children and overcrowded households are important for estimating both HBAI Basic and Full Income Fuel Poverty. Conversely, single person households, under occupied households and respondents with no educational qualifications are more important for predicting Basic Income Fuel Poverty using the standard definition of Basic Income. Similarly, single person households and under occupied households are more important for predicting Full Income Fuel Poverty using the standard definition of Full Income.

Basically, if income is equivalised then larger households and overcrowded households become 'good' predictors of fuel poverty, whereas if incomes are not equivalised then small households (single person) and under occupied households are 'good' predictors of fuel poverty.

Table 8a: Basic Income HBAI FPI Final Model. Binary Logistic Regression.

Variable	ß	se	Wald	Sig	Odds
Property value less than £80,000	.517	.077	45	<.001	1.7
NS-Sec of HRP= routine/semi-routine	.791	.076	107	<.001	2.2
Couple with 2+ dependent children	1.540	.104	220	<.001	4.7
Lone parent hhld	1.125	.109	107	<.001	3.1
Private rental tenant	1.245	.101	151	<.001	3.5
Council tenant	.717	.093	59	<.001	2.0
HRP not in work	1.696	.082	432	<.001	5.5
Dwelling built pre-1920	.732	.089	68	<.001	2.2
Hhld lacks central heating	.367	.048	57	<.001	1.4
Overcrowded household	.640	.152	18	<.001	1.9
Pre-1920 detached dwelling	.929	.167	31	<.001	2.5
Constant	-5.071	.095	2876	<.001	.006
-2LL					*5900*
Chi Sq (df)					*2552(11)*
Nag. Rsq.					*.249*
N					*15872*

Table 8b: Full Income HBAI FPI Final Model. Binary Logistic Regression.

	ß	se	Wald	Sig	Odds
Property value less than £80,000	.476	.079	36	<.001	1.6
NS-Sec of HRP= routine/semi-routine	.601	.082	54	<.001	1.8
Couple with 2+ dependent children	1.288	.101	162	<.001	3.6
Lone parent hhld	.394	.134	9	.003	1.5
Private rental tenant	.858	.107	65	<.001	2.4
HRP not in work	1.263	.084	226	<.001	3.5
Dwelling built pre-1920	.576	.086	45	<.001	1.8
One person hhlds with 7+ rooms	.703	.078	82	<.001	2.0
Hhld lacks central heating	.444	.050	79	<.001	1.6
Respondent with no qualifications	.251	.085	9	.003	1.3
Overcrowded household	.882	.158	31	<.001	2.4
Pre-1920 detached dwelling	.992	.154	42	<.001	2.7
Constant	-4.894	.098	2485	<.001	.007
-2(Log Likelihood)*					*5846*
Chi Sq. (df)					*956(12)*
Nagelkerke R sq.					*.168*
N					*15909*

Tables 8a and 8b show that the two most important predictors of both Basic and Full HBAI Income fuel poverty are if the Household Reference Person is not in work and if the households is large (couples with two or more children). The fuel poverty models derived from the 2003 EHCS needs to be calibrated to the 2001 Census data for England to ensure that the weightings achieve 100% coverage. As the underlying regression equation is additive, the regression coefficients themselves (ß) can be re-calibrated and applied directly to the 2001 Census small area statistics. The final weights used in deriving the small area estimates are shown below.

The number of Basic Income HBAI FPI poor households is equal to:

1.6% of households living in properties valued at less than £80,000
+ 2.4% of households headed by routine/semi-routine employees
+ 4.7% of Couples with 2 or more dependent children families
+ 3.4% of lone parent households
+ 3.8% of private rental households
+ 2.2% of council tenant households
+ 5.1% of households in which the HRP is not in work
+ 2.2% of households living in pre-WW1 dwellings
+ 1.1% of households lacking central heating
+ 1.9% of overcrowded household (based upon occupancy standard)
+ 2.8% of households living in detached pre-WW1 dwellings.

The number of Full Income HBAI FPI poor households is equal to:

1.5% of households living in properties valued at less than £80,000
+ 1.8% of households headed by routine/semi-routine employees
+ 3.9% of Couples with 2 or more dependent children families
+ 1.2% of lone parent households
+ 2.6% of private rental households
+ 3.9% of households in which the HRP is not in work
+ 1.8% of households living in pre-WW1 dwellings
+ 1.4% of households lacking central heating
+ 0.8% of respondent has no qualifications
+ 2.7% of overcrowded household (based upon occupancy standard)
+ 3.0% of households living in detached pre-WW1 dwellings.

The effect of both equivalising incomes and including very low income households in the sample is that English fuel poverty rates decrease slightly to 6.5 per cent for Basic Income and 5.7 per cent for Full Income. The net effect of both of these changes is a slight overall decrease (by about 0.5 per cent) in the English fuel poverty rates (i.e. 6.9 per cent Basic Income and 6.1 per cent Full Income) compared with the EHCS Fuel Poverty model calculations.

Table 9: Summary Results by Settlement Type and Govt. Office Region – Full Income FPI and HBAI Fuel Poverty (%)

		a) Full	b) HBAI Full	Diff. (b-a)
Settlement type:	London	5.4	5.8	0.4
	Urban	6.3	5.5	-0.8
	Suburban	6.0	4.8	-1.2
	Rural	6.6	5.7	-0.9
Govt. Office Region:	East Midland	6.5	5.6	-0.9
	East of England	5.9	4.9	-1.0
	London	5.4	5.8	0.4
	North East	6.6	5.8	-0.8
	North West	6.7	5.9	-0.7
	South East	5.7	4.7	-1.0
	South West	6.2	5.4	-0.8
	West Midlands	6.5	5.7	-0.7
	Yorks & Humber	6.6	6.0	-0.6
TOTAL		***6.1***	***5.7***	***-0.5***

Table 9 (*above*) shows that although the change in the rate of fuel poverty for England is only small (0.5 per cent) the geographic distribution of the change is more significant. Income equivalisation and inclusion of very low income households (e.g. HBAI) results in a major shift in the geography of fuel poverty – London goes from being the 'settlement type area' with the lowest rate of fuel poverty (under the standard definition of full income) to being the settlement type area with the highest rate of fuel poverty, under the HBAI definition of full income. Similarly the second half of Table 9, by Government Office Region, shows that London has the lowest rate of full income fuel poverty (5.4 per cent) well below the national average (6.1 per cent), using the standard definition of full income. However, using the HBAI full income fuel poverty definition, London becomes a region with higher than national average fuel poverty rates.

Figures 7a, 7b and 7c show these significantly different geographical patterns of fuel poverty produced by using HBAI like incomes. With higher rates of fuel poverty in the 'poorest' inner city areas, particularly with regard to the Full Income definition in London, the West Midlands, Greater Manchester and Liverpool and the 'poorer' remote rural regions such as Penwith and Kerrier in Cornwall (Figure 7b and 7c). Conversely, the fuel poverty rates are lower in the outer suburbs of London and the Home Counties 'stockbroker belt'.

Figure 7a: Equivalised Basic Income with Low Income Imputation FPI at 2001 Middle Super Output Area Level (%).

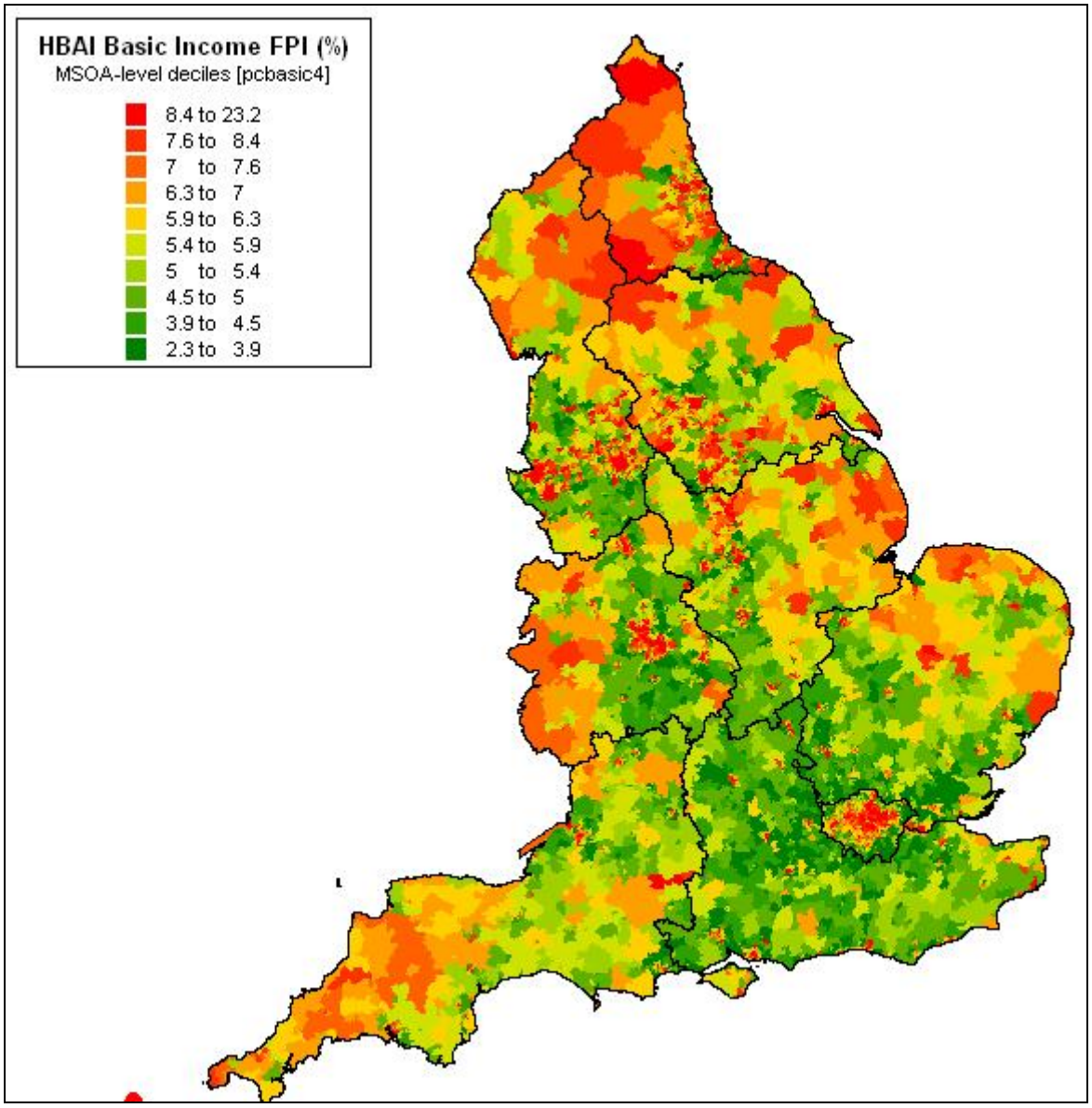


Figure 7b: Equivalised Full Income with Low Income Imputation FPI at 2001 Middle Super Output Area Level (%).

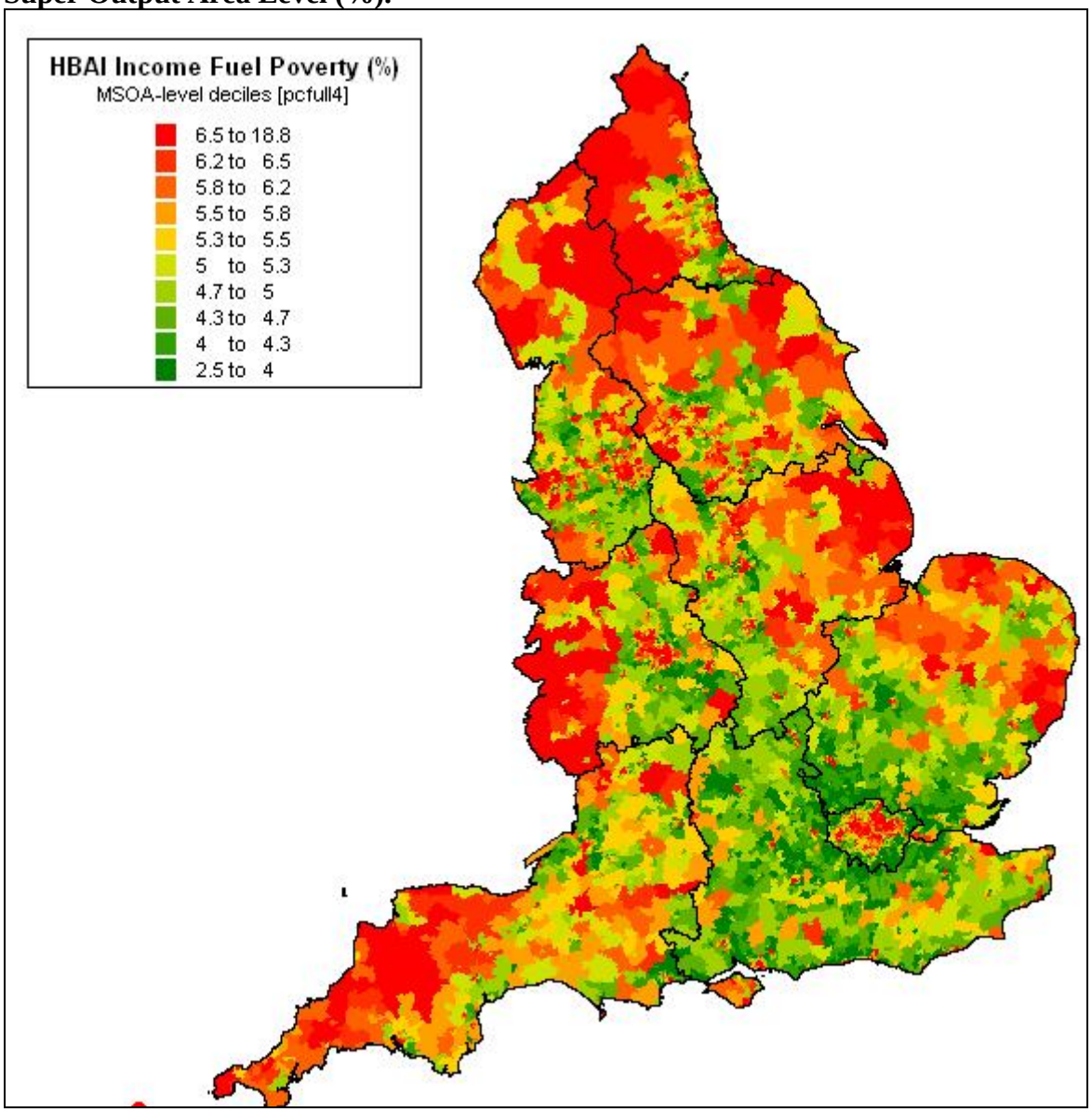
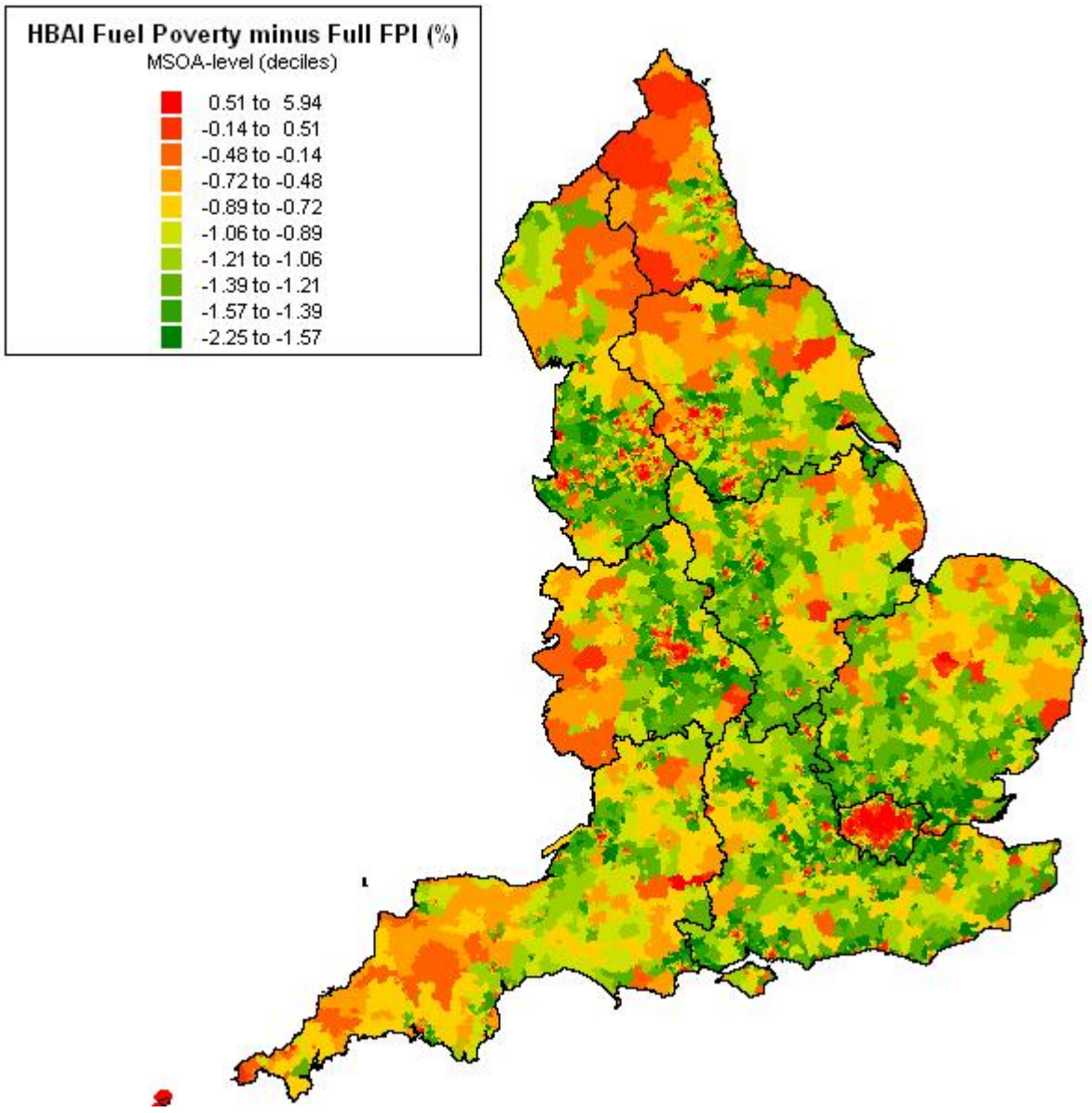


Figure 7c: Difference between HBAI Fuel Poverty and the Full Income FPI Model at 2001 Middle Super Output Area Level (%).



2.8 Summary of Findings

The rate of fuel poverty is relatively insensitive to the way Full and Basic Incomes are measured. Equivalising incomes (i.e. adjusting them for household size and composition) and not increasing the incomes of very low income households does not change the national rates of fuel poverty to a great extent. However, the composition and geography of the fuel poor changes significantly.

If incomes are equivalised then larger households and overcrowded households become more likely to be defined as 'fuel poor', whereas if incomes are not equivalised then small households (single person) and under occupied households are more likely to be defined as 'fuel poor'. At the individual level, income equivalisation results in more children and fewer pensioners being defined as fuel poor. Thus, the 'risk' of fuel poverty becomes more like (but not identical to) the 'risk' of income poverty.

The geography of fuel poverty is also clearly affected by income equivalisation and the inclusion of very low income households. In particular, the map of fuel poverty in England becomes more like a map of income poverty, with increased rates of fuel poverty in London, the West Midlands, Greater Manchester and Liverpool and the 'poorer' remote rural regions such as Penwith and Kerrier in Cornwall.

Conclusion

The ability to find and target households suffering fuel poverty is vital to meet the Government's objective to eliminate fuel poverty, a misery still suffered by millions of households across the UK. As a result of improvements in the data sources and methodological advances made by this project, the new Fuel Poverty Indicator should help policy makers and programme managers to target resources at areas of greatest need by identifying the small areas with the highest rates of fuel poverty.

The approach described here builds upon earlier research (*e.g.* Baker et al., 2002) in order to develop a range of predictive models of fuel poverty at the small area level. As such, these models represent 'best estimates' of the prevalence and distribution of fuel poverty and therefore need to be interpreted in the light of local knowledge and expertise. For example, the results may not be accurate in very 'atypical' areas such as West End ward in Westminster which cover Regents Street, Chinatown and Soho, City of London wards, or the Scilly Isles.

The development of small area fuel poverty indicators is also clearly dependent upon the approach taken to the definition and measurement of income. The Full and Basic Income FPI models, as described in Section One of this report, reflect the current official approach to the definition and measurement of fuel poverty and for this reason are to be preferred as a tool in policy-making and resource allocation. Section Two of this report explores alternative approach to the definition and measurement of fuel poverty on the basis of existing international best practice in the measurement of incomes. Although the overall rate of fuel poverty is relatively insensitive to the way incomes are measured, changes in the measurement of incomes do strongly affect the composition and geography of the fuel poor group.

The HBAI-style approach described in Section Two emphasises the extent of fuel poverty amongst larger households and overcrowded households, and - at the individual level - results in more children and fewer pensioners being defined as fuel poor. Similarly, the HBAI-style approach to measuring fuel poverty results in increased rates of fuel poverty in urban and metropolitan areas (*e.g.* London, West Midlands, Greater Manchester) and in remote rural areas (*e.g.* Devon/Cornwall; East Anglia; Welsh Borders; Northumbria; Lincolnshire).

In contrast, the official FPI indicators place greater emphasis upon the extent of fuel poverty amongst single person and single pensioner households and under-occupied dwellings. The official FPI also accords greater recognition to the prevalence of fuel poverty in 'accessible rural' and suburban areas in preference to inner cities and more remote rural regions. If the FPI is used to assist in the allocation of resources then the official indicator is to be preferred, although it is also useful to investigate the consistency in estimates between the different approaches (i.e. to target the areas with high rates of fuel poverty on all the indicators). Where the objectives reflect wider academic or research interests (e.g. examining the linkages between ill health and fuel poverty) then a decision has to be made about which indicator is most appropriate in a given context .

The small area Fuel Poverty Indicators successfully produced by this research will help policy makers to more cost effectively and efficiently target the areas with the greatest levels of fuel poverty.

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Appendix 1: Results for Global Models

A1.1 Basic Income FPI Logistic Regression Models: Global Models

	%	B	se	Wald	Sig	Odds
Property value less than £80,000	15.8	0.633	0.080	62	<.001	1.883
NS-Sec of HRP= routine/semi-routine	13.2	0.531	0.083	41	<.001	1.701
Single pensioner hhld	18.2	0.730	0.109	45	<.001	2.075
Single non-pensioner hhld	58.6	2.351	0.113	430	<.001	10.493
Lone parent hhld	46.0	1.846	0.146	159	<.001	6.335
Private rental tenant	23.6	0.948	0.123	60	<.001	2.581
Council tenant	13.4	0.538	0.100	29	<.001	1.712
HRP not in work	63.2	2.535	0.100	636	<.001	12.616
Dwelling built pre-1920	16.3	0.653	0.095	47	<.001	1.922
Hhld lacks central heating	12.1	0.483	0.049	98	<.001	1.622
Respondent has no qualifications	13.2	0.531	0.088	37	<.001	1.700
Low occupancy standard	12.0	0.481	0.096	25	<.001	1.618
One person hhlds with 7+ rooms	21.4	0.860	0.108	64	<.001	2.362
Pre-1920 detached dwelling	34.8	1.396	0.184	58	<.001	4.038
Constant		-6.819	0.160	1810	<.001	0.001
-2LL						*5148*
Chi Sq (df)						*2665(14)*
Nag. Rsq.						*.397*
N						*15927*

A1.2 Full Income FPI Logistic Regression Models: Global Models

	%	B	se	Wald	Sig	Odds
Property value less than £80,000	13.1	0.489	0.081	36	<.001	1.630
NS-Sec of HRP= routine/semi-routine	10.0	0.374	0.084	20	<.001	1.453
Single pensioner hhld	20.5	0.765	0.106	52	<.001	2.149
Single non-pensioner hhld	47.7	1.782	0.109	266	<.001	5.940
Lone parent hhld	25.3	0.946	0.176	29	<.001	2.576
Private rental tenant	14.8	0.554	0.127	19	<.001	1.741
HRP not in work	52.9	1.977	0.098	410	<.001	7.224
Dwelling built pre-1920	18.3	0.684	0.091	57	<.001	1.982
Hhld lacks central heating	15.6	0.583	0.049	144	<.001	1.791
Respondent has no qualifications	90.0	0.697	0.089	62	<.001	2.007
Low occupancy standard	24.1	0.900	0.106	72	<.001	2.459
One person hhlds with 7+ rooms	20.9	0.783	0.104	56	<.001	2.187
Pre-1920 detached dwelling	34.2	1.277	0.173	54	<.001	3.588
Constant		-6.470	0.155	1735	<.001	0.002
-2LL						*5192*
Chi Sq (df)						*1996(13)*
Nag. Rsq.						*.324*
N						*15921*

Appendix 2: Results by Settlement Type Stratification

A2.1 Basic Income FPI Logistic Regression Models: Settlement Type Stratification

LONDON

Desc.	%	B	se	Wald	Sig	Odds
Single pensioner hhld	14.2	1.714	0.388	20	<.001	5.551
Single non-pensioner hhld	10.5	2.918	0.386	57	<.001	18.513
Lone parent hhld	12.1	2.117	0.426	25	<.001	8.305
Private rental tenant	5.2	0.895	0.356	6	<.05	2.447
Council tenant	10.2	0.660	0.262	6	<.05	1.935
HRP not in work	16.7	3.161	0.329	92	<.001	23.587
Dwelling built pre-1920	5.2	0.638	0.257	6	<.05	1.892
Constant		-6.870	0.452	231	<.001	0.001
-2LL						*562*
Chi Sq (df)						*289 (7)*
Nag. Rsq.						*0.385*
N						*2296*

URBAN

Desc.	%	B	se	Wald	Sig	Odds
Property value less than £80,000	12.5	0.671	0.107	39	<.001	1.956
NS-Sec of HRP= routine/semi-routine	11.8	0.591	0.103	33	<.001	1.806
Single pensioner hhld	14.2	0.708	0.137	27	<.001	2.030
Single non-pensioner hhld	17.4	2.597	0.142	336	<.001	13.430
Lone parent hhld	12.8	1.843	0.181	103	<.001	6.315
Private rental tenant	12.1	0.964	0.156	38	<.001	2.623
Council tenant	16.6	0.767	0.121	40	<.001	2.154
HRP not in work	17.8	2.592	0.125	433	<.001	13.360
Dwelling built pre-1920	11.1	0.892	0.119	57	<.001	2.440
Hhld lacks central heating	19.2	0.478	0.058	67	<.001	1.612
Respondent has no qualifications	11.6	0.478	0.110	19	<.001	1.613
Low occupancy standard	6.8	0.586	0.117	25	<.001	1.796
One person hhlds with 7+ rooms	20.5	0.821	0.136	36	<.001	2.272
Pre-1920 detached dwelling	14.9	1.751	0.299	34	<.001	5.763
Constant		-7.255	0.209	1208	<.001	0.001
-2LL						*3313*
Chi Sq (df)						*1928 (14)*
Nag. Rsq.						*0.426*
N						*10752*

SUBURBAN

Desc.	%	B	se	Wald	Sig	Odds
Property value less than £80,000	14.3	1.023	0.235	19	<.001	2.783
NS-Sec of HRP= routine/semi-routine	12.7	0.485	0.237	4	<.05	1.623
Single non-pensioner hhld	12.6	1.181	0.300	15	<.001	3.258
Lone parent hhld	14.8	1.906	0.414	21	<.001	6.727
HRP not in work	18.3	2.563	0.284	81	<.001	12.974
Dwelling built pre-1920	9.3	0.667	0.269	6	<.05	1.949
Hhld lacks central heating	26.0	0.603	0.169	13	<.001	1.827
One person hhlds with 7+ rooms	16.3	1.881	0.275	47	<.001	6.559
Constant		-5.518	0.336	269	<.001	0.004
-2LL						*570*
Chi Sq (df)						*253 (8)*
Nag. Rsq.						*0.363*
N						*1508*

RURAL

Desc.	%	B	se	Wald	Sig	Odds
NS-Sec of HRP= routine/semi-routine	18.9	1.143	0.250	21	<.001	3.136
Single pensioner hhld	26.7	1.221	0.288	18	<.001	3.391
Single non-pensioner hhld	12.3	2.185	0.353	38	<.001	8.895
Lone parent hhld	12.3	1.957	0.549	13	<.001	7.075
Private rental tenant	16.3	1.077	0.337	10	<.005	2.937
HRP not in work	20.8	2.271	0.320	50	<.001	9.686
Hhld lacks central heating	36.2	0.891	0.204	19	<.001	2.438
Respondent has no qualifications	20.4	1.514	0.268	32	<.001	4.545
Dwelling with 7+ rooms	7.7	0.816	0.248	11	<.005	2.261
Pre-1920 detached dwelling	10.8	1.331	0.287	21	<.001	3.784
Constant		-6.484	0.415	244	<.001	0.002
-2LL						*564*
Chi Sq (df)						*318 (10)*
Nag. Rsq.						*0.425*
N						*1371*

A2.2 Full Income FPI Logistic Regression Models: Settlement Type Stratification

LONDON

Desc.	%	B	se	Wald	Sig	Odds
NS-Sec of HRP= routine/semi-routine	3.4	-0.827	0.317	7	<.01	0.437
Single pensioner hhld	12.1	1.557	0.408	15	<.001	4.746
Single non-pensioner hhld	6.3	2.362	0.420	32	<.001	10.615
Lone parent hhld	3.5	1.660	0.584	8	<.005	5.260
Private rental tenant	3.9	0.789	0.398	4	<.05	2.201
HRP not in work	10.7	2.953	0.388	58	<.001	19.161
Dwelling built pre-1920	4.0	0.563	0.281	4	<.05	1.755
Hhld lacks central heating	10.1	0.528	0.168	10	<.005	1.696
Low occupancy standard	4.3	0.884	0.323	7	<.01	2.419
Constant		-7.166	0.557	166	<.001	0.001
-2LL						*442*
Chi Sq (df)						*181 (9)*
Nag. Rsq.						*0.321*
N						*2295*

URBAN AREAS

Desc.	%	B	se	Wald	Sig	Odds
Property value less than £80,000	9.5	0.469	0.104	20	<.001	1.599
NS-Sec of HRP= routine/semi-routine	9.3	0.432	0.104	17	<.001	1.540
Single pensioner hhld	14.7	0.735	0.133	31	<.001	2.085
Single non-pensioner hhld	12.9	2.013	0.136	219	<.001	7.488
Lone parent hhld	5.2	0.915	0.222	17	<.001	2.498
Private rental tenant	7.9	0.371	0.166	5	<.05	1.449
HRP not in work	14.5	2.010	0.122	272	<.001	7.461
Dwelling built pre-1920	10.3	0.873	0.112	61	<.001	2.394
Hhld lacks central heating	19.2	0.625	0.057	119	<.001	1.869
Respondent has no qualifications	10.4	0.705	0.113	39	<.001	2.023
Low occupancy standard	6.6	0.880	0.131	45	<.001	2.412
One person hhlds with 7+ rooms	17.9	0.763	0.132	33	<.001	2.144
Pre-1920 detached dwelling		1.363	0.296	21	<.001	3.910
Constant		-6.724	0.200	1130	<.001	0.001
-2LL						*3301*
Chi Sq (df)						*1370 (13)*
Nag. Rsq.						*0.340*
N						*10747*

SUBURBAN AREAS

Desc.	%	B	se	Wald	Sig	Odds
Property value less than £80,000	13.6	0.682	0.226	9	<.005	1.979
NS-Sec of HRP= routine/semi-routine	12.1	0.718	0.230	10	<.005	2.050
Single pensioner hhld	22.3	1.228	0.279	19	<.001	3.415
Single non-pensioner hhld	12.1	1.823	0.323	32	<.001	6.192
Lone parent hhld	12.2	1.799	0.453	16	<.001	6.045
HRP not in work	19.4	2.241	0.284	62	<.001	9.400
Dwelling built pre-1920	11.1	0.886	0.251	12	<.001	2.425
Hhld lacks central heating	25.7	0.517	0.176	9	<.005	1.676
Dwelling with 7+ rooms	9.1	1.108	0.237	22	<.001	3.028
Low occupancy standard	8.5	0.841	0.338	6	<.005	2.319
Constant		-6.486	0.467	193	<.001	0.002
-2LL						*627*
Chi Sq (df)						*242 (10)*
Nag. Rsq.						*0.335*
N						*1508*

RURAL AREAS

Desc.	**%**	**B**	**se**	**Wald**	**Sig**	**Odds**
NS-Sec of HRP= routine/semi-routine	18.4	0.911	0.231	16	<.001	2.488
Single pensioner hhld	29.6	1.213	0.265	21	<.001	3.363
Single non-pensioner hhld	13.7	1.806	0.305	35	<.001	6.086
Private rental tenant	16.3	0.996	0.307	11	<.005	2.707
HRP not in work	22.2	1.846	0.281	43	<.001	6.333
Hhld lacks central heating	34.5	0.741	0.190	15	<.001	2.097
Dwelling with 7+ rooms	9.1	0.872	0.226	15	<.001	2.392
Respondent has no qualifications	21.3	1.287	0.239	29	<.001	3.622
Pre-1920 detached dwelling	12.5	1.169	0.256	21	<.001	3.219
Constant		-5.602	0.340	271	<.001	0.004
-2LL						
Chi Sq (df)						
Nag. Rsq.						
N						

Appendix 3: Results by Govt. Office 'Super-Region' Stratification

A3.1 Basic Income FPI Logistic Regression Models: GO 'Super-Region' Stratification

NORTH EAST & YORKS./HUMBERSIDE

Var.	%	B	se	Wald	Sig	Odds
Property value less than £80,000	29.4	0.955	0.239	16	<.001	2.599
NS-Sec of HRP= routine/semi-routine	24.7	0.805	0.175	21	<.001	2.236
Single pensioner hhld	28.4	0.924	0.221	17	<.001	2.519
Single non-pensioner hhld	74.6	2.426	0.231	110	<.001	11.318
Lone parent hhld	57.8	1.879	0.295	41	<.001	6.545
Private rental tenant	29.3	0.953	0.273	12	<.001	2.594
Council tenant	21.6	0.704	0.204	12	<.005	2.021
HRP not in work	77.0	2.502	0.213	138	<.001	12.211
Dwelling built pre-1920	26.4	0.858	0.211	17	<.001	2.358
Hhld lacks central heating	11.9	0.387	0.106	13	<.001	1.472
Low occupancy standard	17.7	0.577	0.202	8	<.005	1.780
Dwelling contains 7+ rooms	17.8	0.579	0.196	9	<.005	1.785
Constant		*-6.994*	*0.386*	*328*	*<.001*	*0.001*
-2LL						*1050*
Chi Sq (df)						*574 (12)*
Nag. Rsq.						*0.431*
N						*2618*

SOUTH, SOUTH EAST & LONDON

Var.	%	B	se	Wald	Sig	Odds
Property value less than £80,000	13.1	0.600	0.178	11	<.005	1.822
NS-Sec of HRP= routine/semi-routine	6.8	0.311	0.150	4	<.05	1.365
Single pensioner hhld	26.2	1.203	0.214	32	<.001	3.331
Single non-pensioner hhld	55.6	2.551	0.219	136	<.001	12.819
Lone parent hhld	45.7	2.099	0.261	65	<.001	8.154
Private rental tenant	15.5	0.711	0.211	11	<.005	2.036
HRP not in work	60.1	2.759	0.188	216	<.001	15.785
Dwelling built pre-1920	10.8	0.493	0.168	9	<.005	1.638
Hhld lacks central heating	9.8	0.452	0.092	24	<.001	1.571
Respondent has no qualifications	9.5	0.435	0.156	8	<.005	1.545
One person hhlds with 7+ rooms	17.8	0.819	0.180	21	<.001	2.268
Pre-1920 detached dwelling	39.1	1.794	0.313	33	<.001	6.014
Constant		-6.684	0.245	744	<.001	0.001
-2LL						*1661*
Chi Sq (df)						*797 (12)*
Nag. Rsq.						*0.367*
N						*6455*

NORTHWEST, WEST MIDS, EAST MIDS, SOUTH WEST

Var.	%	B	se	Wald	Sig	Odds
Property value less than £80,000	8.5	0.313	0.128	6	<.05	1.368
NS-Sec of HRP= routine/semi-routine	16.1	0.594	0.121	24	<.001	1.812
Single pensioner hhld	14.0	0.518	0.159	11	<.005	1.679
Single non-pensioner hhld	64.4	2.378	0.167	203	<.001	10.778
Lone parent hhld	46.6	1.723	0.220	62	<.001	5.601
Private rental tenant	28.9	1.069	0.182	35	<.001	2.912
Council tenant	16.2	0.597	0.154	15	<.001	1.816
HRP not in work	68.0	2.511	0.147	290	<.001	12.311
Dwelling built pre-1920	19.2	0.708	0.137	27	<.001	2.030
Hhld lacks central heating	14.7	0.543	0.069	61	<.001	1.722
Respondent has no qualifications	19.9	0.736	0.130	32	<.001	2.087
Low occupancy standard	13.6	0.502	0.148	12	<.005	1.652
Dwelling on 5th Storey or higher	37.9	1.401	0.534	7	<.01	4.058
One person hhlds with 7+ rooms	26.9	0.994	0.154	41	<.001	2.701
Pre-1920 detached dwelling	36.0	1.329	0.262	26	<.001	3.776
Constant		-6.819	0.243	790		0.001
-2LL						*2380*
Chi Sq (df)						*1257 (15)*
Nag. Rsq.						*0.406*
N						*6854*

A3.2 Full Income FPI Logistic Regression Models: Basic Income FPI Logistic Regression Models: GO 'Super-Region' Stratification

NORTH EAST & YORKS./HUMBERSIDE

Var.	%	B	se	Wald	Sig	Odds
Property value less than £80,000	22.0	0.766	0.226	11	<.005	2.152
NS-Sec of HRP= routine/semi-routine	21.0	0.730	0.191	15	<.001	2.075
Single pensioner hhld	32.7	1.137	0.232	24	<.001	3.117
Single non-pensioner hhld	65.7	2.286	0.237	93	<.001	9.837
Lone parent hhld	33.2	1.155	0.358	10	<.005	3.175
Private rental tenant	20.8	0.722	0.279	7	<.01	2.059
HRP not in work	58.1	2.022	0.224	81	<.001	7.554
Dwelling built pre-1920	24.9	0.867	0.203	18	<.001	2.380
Hhld lacks central heating	12.9	0.449	0.110	17	<.001	1.566
Respondent has no qualifications	14.4	0.503	0.197	7	<.05	1.653
Low occupancy standard	27.5	0.958	0.226	18	<.001	2.607
Dwelling contains 7+ rooms	15.7	0.546	0.200	7	<.01	1.726
Constant		-7.051	0.397	315	<.001	0.001
-2LL						*984*
Chi Sq (df)						*420 (12)*
Nag. Rsq.						*0.361*
N						*2611*

SOUTH, SOUTH EAST & LONDON

Var.	%	B	se	Wald	Sig	Odds
Property value less than £80,000	14.3	0.629	0.197	10	<.005	1.875
Single pensioner hhld	23.7	1.040	0.197	28	<.001	2.831
Single non-pensioner hhld	38.8	1.706	0.208	68	<.001	5.507
Lone parent hhld	25.3	1.115	0.321	12	<.001	3.048
HRP not in work	44.6	1.964	0.178	121	<.001	7.126
Dwelling built pre-1920	16.4	0.720	0.163	20	<.001	2.055
Hhld lacks central heating	14.3	0.628	0.093	45	<.001	1.875
Respondent has no qualifications	14.6	0.643	0.151	18	<.001	1.902
Low occupancy standard	13.8	0.608	0.188	10	<.005	1.837
One person hhlds with 7+ rooms	17.4	0.766	0.183	18	<.001	2.152
Pre-1920 detached dwelling	36.0	1.581	0.284	31	<.001	4.861
Constant		-6.266	0.265	558	<.001	0.002
-2LL						*1685*
Chi Sq (df)						*590 (11)*
Nag. Rsq.						*0.294*
N						*6457*

NORTHWEST, WEST MIDS, EAST MIDS, SOUTH WEST

Var.	%	B	se	Wald	Sig	Odds
NS-Sec of HRP= routine/semi-routine	13.7	0.416	0.118	12	<.001	1.516
Single pensioner hhld	18.8	0.567	0.153	14	<.001	1.763
Single non-pensioner hhld	59.2	1.792	0.154	135	<.001	6.003
Lone parent hhld	28.2	0.852	0.266	10	<.005	2.344
Private rental tenant	19.8	0.598	0.188	10	<.005	1.819
HRP not in work	65.9	1.993	0.140	203	<.001	7.337
Dwelling built pre-1920	22.6	0.684	0.130	28	<.001	1.981
Hhld lacks central heating	21.3	0.643	0.067	91	<.001	1.902
Respondent has no qualifications	27.8	0.841	0.128	43	<.001	2.318
Low occupancy standard	30.8	0.930	0.165	32	<.001	2.536
Dwelling on 5th storey or higher	38.5	1.165	0.547	5	<.05	3.205
One person hhlds with 7+ rooms	29.4	0.890	0.148	36	<.001	2.435
Pre-1920 detached dwelling	36.1	1.092	0.241	21	<.001	2.979
Constant		-6.315	0.229	758	<.001	0.002
-2LL						*2473*
Chi Sq (df)						*967 (13)*
Nag. Rsq.						*0.333*
N						*6583*