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Predicting Fuel Poverty at Small Area Level

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Introduction

The purpose of this report is to outline the best method of predicting the likely extent of 'fuel' poverty at small area (electoral ward) level using 1991 Census data. Fuel poverty is defined in two different ways: firstly, as *actually* spending 10% or more of normal weekly net household income on fuel, light and power and, secondly, as *needing* to spend 10% or more of normal weekly net household income on fuel, light and power.

Who is likely to be fuel poor?

There are a number of *a priori* assumptions that can be made about the people most likely to suffer from problems of fuel poverty based on theoretical considerations and previous work in this field (e.g. Boardman, 1991). Firstly, people living in fuel poverty are likely to have a relatively low income, therefore, groups which are known to suffer from high rates of relative poverty (Lone parents, unemployed, etc) are also likely to suffer from high rates of fuel poverty. However, not all people suffering from relative poverty (e.g. having an unacceptably low income and a low standard of living) will also suffer from fuel poverty. Conversely, fuel poverty is unlikely to be confined just to those living in relative poverty; for example, people with low incomes who also live in difficult to heat accommodation may be fuel poor, even if their overall standard of living is above the relative poverty threshold. Single pensioners, living in poorly insulated old dwellings, probably make up the bulk of this group. Fuel poverty is, in this case, largely a problem of the cost of heating unmodified pre-WWII housing stock combined with relatively low pension incomes.

The solution to fuel poverty for those people living in relative poverty but living in 'good' housing stock is to raise their incomes whereas the solution for those with high heating costs may in part lie in housing improvements (e.g. better insulation, etc.).

In order to understand the nature of fuel poverty and how best to measure its extent at small area level, it is first necessary to understand how relative poverty and deprivation are defined and measured in the UK.

What is poverty?

In order to measure deprivation/poverty accurately, it is necessary to be precise about the meaning of these terms. Poverty, like evolution is both a scientific and a moral concept. Many of the problems of measuring poverty arise because the moral and scientific concepts are often confused.

There are two basic concepts of poverty in social science: the 'absolute' and 'relative' theories. The 'absolute' concept of poverty is dominated by the individual's requirements for physiological efficiency. However, this is a very limited conception of human needs, especially when considering the roles that men, women and children play in society. People are not just physical beings, they are social beings. They have obligations as workers, parents, neighbours, friends and citizens that they are expected to meet and which they themselves want to meet. Studies of people's behaviour after they have experienced a drastic cut in resources show that they sometimes act to fulfil their social obligations before they act to satisfy their physical wants. They require income to fulfil their various roles and participate in the social customs and associations to which they have become habituated and not only to satisfy their physical wants (Townsend and Gordon, 1991).

Poverty can be defined as where resources are so seriously below those commanded by the average individual or family that the poor are, in effect, excluded from ordinary living patterns, customs and activities. As resources for any individual or family are diminished, there is a point at which there occurs a sudden withdrawal from participation in the customs and activities sanctioned by the culture. The point at which withdrawal escalates disproportionately to falling resources can be defined as the poverty line or threshold (Townsend, 1979; 1993).

In scientific terms, a person or household in Britain is 'poor' when they have both a low standard of living and a low income. They are not poor if they have a low income and a reasonable standard of living or if they have a low standard of living but a high income. Both low income and low standard of living can only be accurately measured relative to the norms of the person's or household's society. Standard of living includes both the material and social conditions in which people live and their participation in the economic, social, cultural and political life of the country. Figure 1 below illustrates this concept of poverty.

Figure 1: Definition of poverty



This 'relative' concept of poverty is now widely accepted (Piachaud, 1987), however, whilst it is not easy to measure poverty directly, it is possible to obtain measures of 'deprivation'. These two concepts are tightly linked and there is general agreement that the concept of deprivation covers the various conditions, independent of income, experienced by people who are poor, while the concept of poverty refers to the lack of income and other resources which makes those conditions inescapable or at least highly likely (Townsend, 1987).

Put simply, a low standard of living is often measured by using a deprivation index (high deprivation equals a low standard of living) or by consumption expenditure (low consumption expenditure equals a low standard of living). Of these two methods deprivation indices are more accurate since consumption expenditure is often only measured over a brief period and is obviously not independent of available income. Deprivation indices are broader measures because they reflect different aspects of living standards, including personal, physical and mental conditions, local and environmental facilities, social activities and customs. Heating deprivation is often incorporated into the measurement of low standard of living in many specialist poverty surveys.

What is fuel poverty?

There is a long history of concern about fuel poverty in the UK and attempts at scientific study using modern social science methodology date back to the mid-1970s (for example, Department of Energy, 1978). Fuel poverty is considered to be one of the potential causes of estimated 40,000 excess winter deaths per year in Britain (see Wilkinson *et al*, 2001 for discussion).

A fuel poor household is one that cannot afford to keep adequately warm at reasonable cost. For the purposes of the *UK Fuel Poverty Strategy* which the government launched in November 2001, a fuel poor household has been operationalised as one which needs to spend more than 10% of its income on all fuel use, to heat the home to a satisfactory standard and for lighting, cooking and running domestic appliances (DEFRA & DTI, 2001).

Income is defined as including Housing Benefit or Income Support for Mortgage Interest (ISMI) and fuel use is defined as total fuel uses for both heating and non-heating purposes. The definition of a 'satisfactory standard of heating' varies depending upon household type (DETR, 2000a):

- For households in work or fulltime education it is considered to be 21°C in the living room and 18°C in the other occupied rooms for the whole house for 9 hours a day (morning & evening) – this is termed the *Standard* heating regime.
- For households likely to be at home all day it is considered to be 21°C in the living room and 18°C in the other occupied rooms for the whole house for 16 hours a day (all day) – this is termed the *Full* heating regime.
- For under-occupied households¹ it is considered to be 21°C in the living room and 18°C in the other occupied rooms for half of the house for 16 hours a day (all day) – this is termed the *Partial* heating regime.

¹ Under occupancy is defined in terms of the 1968 Parker Morris standard which set building regulations on the minimum floor area for a home depending on the number of occupants (DTI & DEFRA, 2002a,b).

The heating cost model (SAP – Standard Assessment Procedure) allows for different regional climatic conditions and the actual fuel tariffs of households (BRE, 1998). Non heating costs are calculated for lighting, cooking and other appliances (e.g. refrigerators, etc) using the BREDEM-12 (Building Research Establishment Domestic Energy Model) algorithms (Anderson *et al*, 1996).

The 10% fuel poverty income threshold has a long history. The 1988 Family Expenditure Survey (FES) showed that households in the lower three income deciles spent, on average, 10% of their income (not including Housing Benefit or ISMI as part of income) on fuel for all household uses (DEFRA & DTI, 2001). It was assumed that this could be taken as representing the maximum amount that low-income households could reasonably be expected to spend on fuel.

The current definition of fuel poverty is very complex and has been developed over many years of research. Variations of this definition have been used in previous research and in different parts of the UK, for example, in the 1991 *English House Conditions Survey* used different heating regimes and definitions of income (DoE, 1996) and in Northern Ireland the definition of fuel poverty has covered the cost of heating only (Boardman and Fawcett, 2002).

The measurement of poverty and deprivation

From these definitions, it is clear that, in order to measure both poverty/deprivation and fuel poverty accurately, surveys or censuses must be used that both establish the ‘normal’ or ‘average’ standard of living of the majority in a society/culture as well as any ‘enforced’ reductions in this standard due to lack of resources. For example, a fuel poverty line of 10% net household income would be inappropriate in a tropical country where heating requirements are less than in the UK. Similarly, a higher expenditure threshold for fuel poverty would probably be appropriate for people in Siberia or Northern Canada.

Social scientists have been using deprivation surveys to study poverty in Britain for over a hundred years. All these surveys have shown that certain groups are more likely to suffer from multiple deprivation than others (e.g. lone parents and the unemployed are not equally likely to be living in poverty and indices that consider them to be are probably wrong.) Therefore, Census based deprivation indices that give equal weight to their component variables are likely to yield inaccurate results.

Since all Census based deprivation indices are generally composed of surrogate or proxy measures of deprivation rather than direct measures, there are two basic requirements they should fulfil to ensure accuracy:

- 1 The components of the index should be weighted to reflect the different probability that each group has of suffering from deprivation; and
- 2 the components of the index must be additive, e.g. if an index is composed of two variables, unemployment and lone parenthood, then researchers must be confident that unemployed lone parents are likely to be poorer than either lone parents in employment or unemployed people who are not lone parents.

Weighted indices also have the advantage that their results are often much easier to understand, e.g. saying that, in the South West, 15% of households are living in fuel poverty has a much greater intuitive meaning than saying that the South West has a fuel poverty Z-score of -2.6.

Despite the fact that Census based measures of fuel poverty are only indirect measures, the national Census is currently the only reliable source of high quality statistical information at small area level.

Obtaining weightings for Census based fuel poverty indices

The easiest method of obtaining weightings for component variables in Census based fuel poverty indices is to use a survey (conducted at or around the same time as the Census) that can be used to accurately measure fuel poverty. The most appropriate surveys for this purpose are the Family Expenditure Surveys (FES) which measure both household income and expenditure in great detail and/or the English House Conditions Surveys (EHCS) which provide detailed measurements of housing conditions, heating requirements and other fuel costs. The FES is the best survey to measure fuel poverty defined as *actual* expenditure of more than 10% of income on fuel. The EHCS is the best survey to measure fuel poverty when defined as a *needed* expenditure of more than 10% of income on fuel (the Government's current definition).

The FES is a continuous survey with an annual sample of around 10,000 households (about 1 in 2000 of all United Kingdom households) about 60% of which co-operate by providing the interviewers with information about the household, household and personal incomes, certain payments that recur regularly (e.g. rent, gas and electricity bills, telephone accounts, insurances, season tickets and hire purchase payments) and in maintaining a detailed expenditure record for 14 consecutive days.

The original purpose of the survey was to provide information on spending patterns for the United Kingdom Retail Price Index (RPI). The survey is a cost efficient way of collecting a variety of related data that Government Departments require to correlate with income and expenditure at household, tax unit and person levels.

The annual FES survey has been in existence since 1957 (with an earlier large scale survey in 1953/54) and was one of the first Department of Employment (DoE) systems to be computerised in the early 1960s (ONS, 2000).

It is possible to calculate the number of households which spend 10% or more of their disposable income on fuel, light and power and then compare the characteristics of these households using the limited measures in common to both the 1991 Census and the 1991 and 1992 FES. Table 1 below shows the univariate odds that particular types of households are living in fuel poverty in 1991/92 in both the UK and the South West region.

Table 1: Univariate Odds (Relative Risk Ratios) of Census 1991 variables as predictors of fuel poverty (> 10% actual expenditure) in the 1991 and 1992 Family Expenditure Surveys

| Variable | United Kingdom 91/92 FES Combined (N=14,474) | South West 1991/1992 FES combined (N=1,243) | United Kingdom 1991 FES UK (N=7,506) | United Kingdom 1992 FES (N=7,418) |
|-------------------------|---|--|---|--|
| Lone parent | 4.9 | 4.1 | 5.2 | 4.6 |
| Single Pensioner | 3.5 | 3.8 | 3.4 | 3.6 |
| No car | 2.8 | 2.8 | 2.8 | 2.7 |
| No earners | 2.8 | 2.6 | 2.8 | 2.8 |
| Renter | 2.5 | 2.4 | 2.9 | 2.3 |
| No central heating | 1.5 | 1.5 | 1.7 | 1.4 |
| Large Family | 1.4 | 0.7 | 1.2 | 1.6 |
| Low Social Class (IV&V) | 1.1 | 1.0 | 1.1 | 1.1 |
| Overcrowded | 0.9 | 0.9 | 0.7 | 1.0 |
| Not Self Contained | 0.7 | 0.8 | 0.5 | 0.9 |

Table 1 shows that, in the UK in 1991/1992, lone parent households were almost five times (4.9) more likely to be living in fuel poverty than the rest of the population. Similarly, single pensioners were more than three times as likely to suffer from fuel poverty and households with no car, with no one in paid work (no earners) and living in rented accommodation, were more than twice as likely to be living in fuel poverty. Conversely, households in overcrowded accommodation (more than 1 person per room) or in dwellings where they had to share some rooms such as bedsits (not self contained) were slightly less likely to be living in fuel poverty than the general population (although this is not a statistically significant result).

The second column in Table 1 shows the results from the South West region. In general, they are similar to those for the UK as a whole, however, there are a number of minor differences. For example, in the South West, single pensioners seem slightly more likely to be fuel poor and lone parents slightly less likely to be fuel poor than in the UK as a whole.

The English House Condition Survey (EHCS) is a dwelling based survey which, up to and including the year 2001, was carried out once every five years. The surveys provide a major source of information for the development and monitoring of housing policies on the repair, improvement and energy efficiency of the housing stock. The survey collects information on the condition and energy efficiency of the stock, repair and maintenance activity and the characteristics of households occupying different sectors of the stock. The 2001 survey will be the eighth and last quinquennial survey as, from April 2002, it will move to a continuous basis.

Currently, the latest available data is from the 1996 survey which had five separate but related parts:

1. Interview Survey: interviews with householders to determine their characteristics (including financial circumstances), attitudes to their homes, repair and improvement work undertaken and heating arrangements.
2. Physical Survey: a survey of dwellings to provide a description of the stock and its present condition.

3. Fuel Survey: which adds to information collected in the Interview and Physical Surveys on energy usage by collecting actual energy consumption and expenditure figures over the last eight consecutive quarters.
4. Postal Survey: a survey of local authorities and housing associations to identify work they have undertaken on their stock and action taken by local authorities on private sector stock.
5. Valuation Survey: a survey of current market values.

Valid information from the Interview Survey was obtained for 16,100 addresses and the remaining surveys were sub-samples of these (DETR, 1998).

The version of the 1996 EHCS dataset which has been released to the public contains information on the SAP rating and the total estimated (SAP) *heating* costs for each household but it does not contain an estimate of the total needed *full fuel* costs (DETR, 2000b). For this analysis, these data have been provided to the research team by Terry McIntyre from DEFRA with the help of Julie Dunster from BRE. It differs in some minor respects from the full fuel cost variable used in previous Government studies of fuel poverty (e.g. DETR, 2000a).

Table 2 shows that, in England in 1996, households with no access to a car were three times more likely to be living in fuel poverty than the rest of the population, where fuel poverty is defined as needing to spend more than 10% of basic income on total fuel costs. Similarly, if a more restrictive definition of fuel poverty is used (defined as needing to spend more than 10% of income on *heating*) then households with no access to a car were slightly more than three times (3.3) more likely to be living in fuel poverty than the rest of the population. Single pensioners, under occupied households (more than five rooms per person), households with no central heating and households with a person under 60 unemployed were more than twice as likely to be living in fuel poverty. Conversely, households in overcrowded accommodation (more than one person per room) were slightly less likely to be living in either fuel or heating poverty than the general population.

Table 2: Univariate Odds (Relative Risk Ratios) of Census 1991 variables as predictors of fuel poverty (> 10% needed expenditure) in the 1996 English House Conditions Survey

| Variable | England 1996 EHCS Total Fuel Cost (N=13,711) | England 1996 EHCS Heating Cost (N=13,711) |
|---------------------------------------|---|--|
| No car | 3.0 | 3.3 |
| Single Pensioner | 2.7 | 3.3 |
| Under occupied (> 5 rooms per person) | 2.4 | 3.9 |
| No central heating | 2.2 | 3.0 |
| Unemployed | 2.1 | 2.4 |
| Private renter | 1.9 | 2.6 |
| Disabled | 1.7 | 1.5 |
| Lone parent | 1.6 | 1.4 |
| LA or RSL renter | 1.6 | 1.1 |
| Overcrowded (> 1 person per room) | 0.8 | 0.5 |

There are some interesting comparisons between Tables 1 and 2 (actual and needed expenditure fuel poverty definitions). Both lone parents and single pensioners are both at high risk of fuel poverty using either definition. However, both these groups are somewhat more likely to be fuel poor when measured using the actual expenditure definition than when using the needed expenditure definition that is

currently favoured by the Government. It should also be noted that not all variables are available in both surveys (e.g. under occupancy and disability cannot be measured in the FES and Social Class is not available in the EHCS public dataset). Over crowding is not a significant predictor of fuel poverty using either definition.

Measuring *actual* expenditure fuel poverty using the 1991 Census

It is possible to obtain weightings for the best subset of fuel poverty indicator variables that were measured in both the 1991 Census and the Family Expenditure Surveys using a multivariate statistical technique of logistic regression (Gordon and Forrest, 1995; Gordon, 1995). This procedure has been used successfully with the 1990 *Breadline Britain Survey* to produce weighted Census based poverty indices. An evaluation of the 10 most widely used poverty and deprivation indices, undertaken on behalf of the Joseph Rowntree Foundation (Lee *et al* 1995; Lee & Murie, 1997), concluded that the Breadline Britain index of Gordon and Forrest (1995) was “*the most representative of deprivation nationally*”. A similar review of deprivation indices by the University of York also concluded that “*if one is interested in identifying areas where there are likely to be high levels of area dissatisfaction amongst residents then, of the available indices, it is the Breadline Britain measure which does the best job and the DOE Local Conditions Measure which is the least adequate for this purpose*” (Burrows & Rhodes, 1998). Recently, researchers at the University of Kent have also concluded that “*It would seem that the use of a weighted deprivation index based on individual level data and Census data produces a more accurate and more easily understood method of estimation deprivation within an area... the Breadline Britain weightings ... provide a reasonable estimate of the number of deprived living within smaller areas*” (Sanders, 1998)

Initially, 10 variables were selected that have been shown to be reasonable proxy indicators of deprivation by other studies and were measured in similar ways in both the FES and the 1991 Census (Gordon and Loughran, 1997). These were:

1. **No Earners**; households with no adult in employment
2. **Low Social Class**: households with the head in Social Class IV or V
3. **Lone Parents**: households with dependent children and one adult
4. **Large Families**: households with four or more dependent children
5. **Not Self Contained**: households not in self contained accommodation
6. **Overcrowded**: households with more than one person per room
7. **No Central Heating**: household with no central heating
8. **No Car**: households with no access to a car
9. **Renting**: households in rented accommodation (LA and private).
10. **Single Pensioner**: households with one adult aged over 65 if a man or over 60 if a women

The step-wise logistic regression analysis allowed the best subset of variables to be selected that were proxies of fuel poverty (as defined by the FES) and provided weightings for each variable after allowing for the overlaps between variables (e.g. Lone Parents households may also be Low Social Class or No Earners households). Table 3 below provides a summary of this multivariate analysis.

Table 3: Multivariate Odds (Relative Risk Ratios) of Census 1991 variables as predictors of fuel poverty (> 10% of actual expenditure) in the 1991 and 1992 Family Expenditure Surveys

| Variable | United Kingdom 91/92 FES combined (N=14,474) | South West 1991/1992 FES combined (N=1,243) | United Kingdom 1991 FES UK (N=7,506) | United Kingdom 1992 FES (N=7,418) |
|-------------------------|---|--|--|---|
| No earners | 5.4 | 5.1 | 5.5 | 5.3 |
| Lone parent | 3.2 | 3.5 | 3.1 | 3.2 |
| Renter | 2.4 | 2.4 | 3.4 | 1.9 |
| Low Social Class (IV&V) | 2.0 | 2.0 | 2.0 | 2.0 |
| No car | 1.8 | 1.2 | 1.6 | 1.9 |
| Single Pensioner | 1.6 | 2.3 | 1.6 | 1.6 |
| No central heating | 1.1 | 1.3 | 1.2 | 1.0 |
| Large Family | 1.0 | 1.2 | 0.8 | 1.2 |

Once the overlap between variables is allowed for, the most significant multivariate predictors of fuel poverty are somewhat different than the individual level predictors shown in Table 1. Households with no earners are more than five times (5.4) more likely to be fuel poor and lone parent households three times more likely in both the UK and the South West region. Renters and those households with heads in Social Classes IV & V are twice as likely to be fuel poor. It must be noted that low social class is a much more significant predictor of fuel poverty, when combined with other variables, than it is in isolation. In the South West, single pensioners are much more likely to be fuel poor than in the UK as a whole (odds of 2.3 to 1 compared with 1.6 to 1). Conversely, those without a car are less likely to be fuel poor in the South West (odds of 1.2 to 1 compared with 1.8 to 1). The decline in the importance of single pensioners as a predictor of fuel poverty (compared with the univariate results) is due to the fact that many single pensioner households have no earners.

The number of fuel poor households in Britain =
 24.5% of No Earner Households +
 16.7% of Lone Parent Households +
 13% of Renting Households
 10.1% of Low Social Class Households +
 8.6% of Households with No Access to a Car +
 6.6% of Single Pensioner Households.

The number of fuel poor households in the South West region =
 22.3% of No Earner Households +
 17.5% of Lone Parent Households +
 12.8% of Renting Households
 9.4% of Low Social Class Households +
 11.5% of Single Pensioner Households.

The differences between the optimised all Britain weighted index and the SW region index are that, in the South West, lack of access to a car is not a statistically significant variable once all the other groups have been allowed for. Also in the South West region, single pensioner households are more likely to be fuel poor and therefore have a significantly higher weighting.

Measuring *needed* expenditure fuel poverty using the 1991 Census

Step-wise logistic regression analysis was used with the EHCS data using both the total fuel need and heating need fuel definitions. Initially, 11 variables were selected that have been shown to be reasonable proxy indicators of fuel poverty by other studies and were measured in similar ways in both the 1996 EHCS and the 1991 Census (DETR, 2000a; NEA, 2000). These were:

1. **Unemployed**: households with an adult under 60 unemployed
2. **Lone Parents**: households with dependent children and one adult
3. **Under occupied²**: households with more than 5 rooms per person
4. **Overcrowded**: households with more than one person per room
5. **No Central Heating**: household with no central heating
6. **No Car**: households with no access to a car
7. **Renting**: households in rented accommodation (LA and private)
8. **Private Renter**: households in accommodation rented from a private landlord
9. **LA/RSL Renter**: households renting from a social landlord
10. **Single Pensioner**: households with one adult aged over 65 if a man or over 60 if a women
11. **Disabled**: household with at least one sick/disabled member

The step-wise logistic regression analysis allowed the best subset of variables to be selected that were proxies of fuel poverty (as defined by the FES) and provided weightings for each variable after allowing for the overlaps between variables. Table 4 below provides a summary of these multivariate analyses.

Table 4: Multivariate Odds (Relative Risk Ratios) of Census 1991 variables as predictors of fuel poverty (> 10% needed expenditure) in the 1996 English House Conditions Survey

| Variable | England 1996 EHCS Total Fuel Cost (N=13,711) | England 1996 EHCS Heating Cost (N=13,711) |
|---------------------------------------|---|--|
| Unemployed | 2.9 | 2.8 |
| Under occupied (> 5 rooms per person) | 2.6 | 4.3 |
| No car | 2.5 | 2.1 |
| Single Pensioner | 2.4 | 1.6 |
| No central heating | 2.4 | 3.0 |
| Private renter | 2.1 | - |
| Lone parent | 2.1 | - |
| Disabled | 1.6 | 1.2 |
| LA or private renter | - | 1.3 |

Once the overlap between variables is allowed for, the most significant multivariate predictors of fuel poverty (needed expenditure) are somewhat different than the individual level predictors shown in Table 2. Households with unemployed people under 60 are almost three times (2.9) more likely and households with no access to a car more twice as likely to be both fuel and heating poor. Under occupied households are at greater relative risk of being heating poor (4.3) than total fuel cost poor (2.6). Similarly, those households with no central heating are also at greater relative risk of being heating poor

² CHAID (Chi-squared automatic interaction detector) analysis was used to determine the optimum threshold level for under occupancy (in terms of number of rooms per person) in order to predict fuel and heating poverty

than total fuel cost poor. By contrast, private renters and lone parents are at greater risk of being total fuel cost poor than heating poor.

The number of fuel poor households in England =
22.3% of Unemployed Households +
20.1% of Under Occupied Households +
19.8% of Households with No Access to a Car +
19.3% of Households with No Central heating +
19.2% of Single Pensioner Households +
16.8% of Lone Parent Households +
16% of Private Renting Households
13% of Households with a Disabled person.

The number of heating poor households in England =
15.5% of Under Occupied Households +
10.7% of Households with No Central heating +
10% of Unemployed Households +
7.4% of Households with No Access to a Car +
5.6% of Single Pensioner Households +
4.4% of Renting Households
4% of Households with a Disabled person.

The differences between the total fuel cost weighted index and the heating cost index are that, in the heating cost index, lone parent households are not a statistically significant variable once all the other groups have been allowed for. Similarly, private renting households are better predictors of total fuel cost poverty than social and private rented households combined. All the weightings for the total fuel cost index are significantly higher than the heating cost index weightings as almost twice as many people are defined as fuel poor in England if total fuel costs are used.

Correspondence between the different methods of estimating fuel poverty

In this study, four different methods have been used to provide estimates of fuel poverty at 1991 electoral ward level:

- 1) Needing to spend more than 10% of income on all fuel costs (EHCS fuel poor).
- 2) Needing to spend more than 10% of income on heating costs (EHCS heating poor)
- 3) Actual expenditure of more than 10% of income on all fuel costs (FES fuel poor)
- 4) Actual expenditure of more than 10% of income on all fuel cost in the South West region (FES SW fuel poor)

Table 5 below shows the correlation between the results of these four different methods for the 8,594 1991 Census electoral wards of England.

Table 5: Pearson's correlations for different fuel poverty estimation methods for the 8,594 1991 Census electoral wards of England

| | % EHCS fuel poor (expenditure needed) | % EHCS heating poor (expenditure needed) | % FES fuel poor (actual expenditure) | % FES SW fuel poor (actual expenditure) |
|--|---|--|--|---|
| % EHCS fuel poor (expenditure needed) | | | | |
| % EHCS heating poor (expenditure needed) | 0.99 | | | |
| % FES fuel poor (actual expenditure) | 0.88 | 0.83 | | |
| % FES SW fuel poor (actual expenditure) | 0.84 | 0.97 | 0.93 | |
| % Poor Households (Breadline Britain index) | 0.87 | 0.84 | 0.98 | 0.91 |

All the correlations shown in Table 5 are significant. There is a very high correlation (0.99) between the two EHCS based estimates despite the fact that the heating poor index uses seven variables and the total fuel poor method used eight variables and that there are some significant differences in both the variables used and the weightings they receive. Although there are significant differences in the types of households that are most likely to be heating poor compared with those most likely to be fuel poor, the geographic distribution of these households is very similar at electoral ward level.

There is a slightly lower (but still very significant) degree of correlation between the EHCS estimate of fuel poverty (needed expenditure on all fuel) and the two FES based measures (actual expenditure). However, the correlation between the two FES based measures (0.93) is smaller than between the EHCS heating poverty index and the FES SW fuel poverty index (0.97), which indicates that the same types of household that are likely to have high fuel expenditures in the South West may also be likely to suffer from heating poverty. This result is unsurprising given the relatively low levels of central heating recorded in dwellings in the South West region in the 1991 Census (particularly in Cornwall) and the low level of wages in many of the more rural parts in the South West.

There are very high correlations between the number of poor households at ward level (Breadline Britain index) and the FES based measures of fuel poverty (greater than 0.9). This indicates that areas where households have high actual fuel expenditures are also areas where there is a lot of relative poverty. By contrast, electoral wards with high rates of needed fuel expenditure may not always be those with the highest poverty rates – other factors significantly effect needed fuel expenditure apart from low incomes.

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