Chapter 6
Improving Data and Measurement to Optimise Decision Making

Key Points

Average energy expenditures of households with prepayment meters are under-estimated by a large margin if a significant measurement issue in the Living Costs and Food Survey (LCF) and its precursors is left uncorrected. This may affect previous analysis which has used LCF data

After applying a correction, central estimates of fuel poverty rates based on reported energy expenditures exceed official fuel poverty rates based on required (modelled) energy expenditure in some years

A definitive comparison of required and reported energy expenditures requires questions about the latter in the English Housing Survey

There is limited overlap between fuel poverty indicators based on energy expenditures (10% and LIHC metrics) and households' perceptions of unaffordable warmth

In-home temperature measurements seem necessary to form definitive explanations for the lack of overlap

Policymaking would be better informed if anonymised raw data from surveys commissioned by economic regulators were publicly shared by default

1 Introduction

The data available to policymakers provide them with a picture of the world and identifies potential issues in the retail energy market. High quality data provide policymakers with a better understanding of the world, which should lead to more informed policies and better outcomes for consumers. The converse is also true: poor quality, or misunderstood, data risk policy errors and detrimental outcomes for consumers. Here some key data issues encountered during our research are explored. This chapter contains three sections focussed on: (i) household energy expenditures (ENEX), related to Chapter 2; (ii) alternative fuel poverty (FP[1]) indicators, related to Chapter 5; and (iii) the use of market monitoring surveys, which is particularly relevant to Chapter 4.

The most significant issue identified is that the main source for household ENEX, the Living Costs and Food Survey (LCF) and its precursors, contains a serious measurement issue from the early-1990s until 2013. Data appear to be missing for a significant proportion of households with prepayment meters (PPMs). Correcting for this issue substantially increases average ENEX among PPM households, a group disproportionately on low incomes. Estimates of some earlier studies (which used the uncorrected data) regarding the distribution of ENEX, energy consumption and emissions across households may be affected by this data issue.[2]

The FP rate based on reported[3] ENEX, after applying our PPM correction, is compared with the official FP rate based on 'required' ENEX. Which type of ENEX yields the higher FP rate varies through time, so reported ENEX does not always result in lower FP rates than required ENEX. The methodology for calculating required ENEX suggests a more neutral label is modelled ENEX. Using a different dataset, we further show that only a small percentage of households identified as FP using 'official' ENEX indicators self-report an inability to afford adequate warmth. This raises fundamental questions about the phenomena identified by alternative FP indicators; explaining the lack of overlap likely requires survey data to be combined with data on in-home energy use, in this instance achieved temperatures and temperature preferences.

Our third set of insights result from analysing Ofgem's micro and small business (MSB) surveys. UK economic regulators would maximise the insights from costly surveys by having a starting presumption of sharing anonymised survey data, so that external bodies can perform additional analysis and form independent conclusions. This would be particularly valuable if resource constraints limit further analysis by the regulator. If sharing is impossible, a detailed explanation should be made public.

2 Pre-Payment Meters, Missing Data and Energy Expenditures

There are three main methods to pay for electricity and gas in the UK: by Direct Debit, in arrears (Standard Credit) or by PPM. PPMs have traditionally been installed in rental properties and have increasingly been used to manage debt, so they are located disproportionately in low income households. Unlike direct debit and arrears, until 2013 PPM gas and electricity expenditures were recorded in the LCF using a two-week expenditure diary where households recorded expenditures as they occurred.

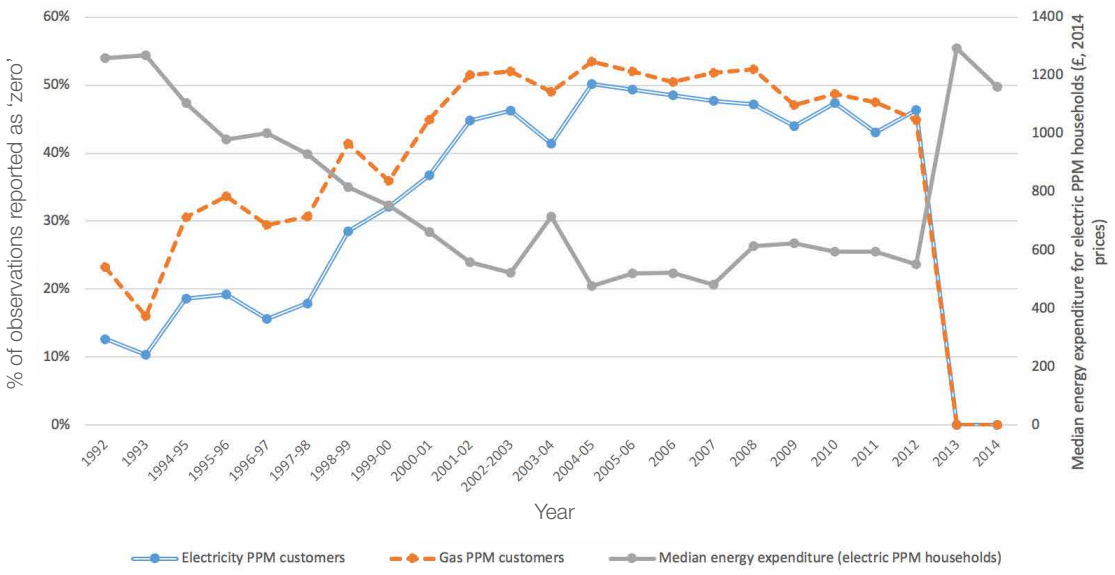
1 We also use FP to denote 'fuel poor'.
2 For example, Druckman and Jackson (2008) and Buchs and Schnepf (2013).
3 Reported ENEX is the ENEX reported by households in surveys.

2.1 Many PPM users' ENEX data appear to be missing

In the PPM ENEX data the proportion of households reporting zero expenditure on electricity and/or gas increased throughout the 1990s[4] until around 50% of gas PPM customers were reporting zero gas expenditure in the first decade of the 2000s (Figure 1). Figure 1 also shows that as the proportion of PPM customers reporting zero increased, the median ENEX of PPM customers fell. Why the frequency of zeros increased during the 1990s is unclear.

Figure 1 Percentage of PPM customers with zero electricity/ gas expenditure plotted against median ENEX for electricity PPM customers

(Data: Living Costs and Food Survey and precursors)[5]



Advani et al (2013) and Buchs and Schnepf (2013) note that one possible reason for the zero expenditures is infrequency of purchase, i.e. households top up their PPM less frequently than once every two weeks. In this interpretation mean (average) ENEX from the expenditure diary would still be broadly accurate of 'true' average ENEX.[6]

4 See Figure A.3, pg 89, Advani et al (2013) for the rates of 'zero' PPM expenditures prior to 1992.
5 Deller and Waddams Price (2018a). Details of our research papers' methodologies are provided in Appendix 1.
6 Here the zeros would be offset by larger positive ENEX observations covering more than two weeks for those households that did top-up during the two-week diary window.

However, we believe,[7] the zero observations are more appropriately treated as missing data. Consequently, apparent observations of zero ENEX for PPM households need to be replaced with an ENEX estimate if average ENEX and the ENEX distribution are to be accurate. Equally, we acknowledge, a small proportion of households' top-ups may have lasted for longer weeks and some of the zeros in the two-week expenditure diaries are real.[8] As a result, our ENEX, ENEXShr and FP figures in years prior to 2013 are technically upper bounds.

The decision to impute PPM ENEX is based on a range of evidence. Most importantly, the drop in the number of 'zero' observations in 2013 coincides with a change in the survey question for PPM customers. From 2013 households were asked the amount of their last top up and the period it would normally last. Figure 1 highlights how this change caused observations of zero ENEX to disappear and at the same time median ENEX for PPM households more than doubled. Since this dramatic increase in median ENEX only occurs for PPM households, we conclude the question change was responsible.

Other evidence also supports treating the zeros as missing; in particular: (i) two surveys[9] report a clear majority of PPM households top up weekly, so infrequency of purchase seems an unlikely explanation; and (ii) PPM prices did not increase significantly between 2012 and 2013[10], so prices do not explain the sudden jump in PPM ENEX recorded by the LCF. Moreover, since the LCF sets expenditure to zero unless a respondent records positive expenditure, zeros can easily mask missing data.

2.2 Correcting for PPM users' missing data

To correct for the zero expenditures, ordinary least squares regressions[11] were performed based on data from the PPM households who reported positive expenditures for electricity(gas). These regressions produced a model that, when combined with the characteristics of PPM households reporting zero electricity(gas) expenditure, could estimate the annual electricity(gas) expenditure for each PPM household with missing data. The correction's impact is shown in Figure 2. If the correction is not applied, average ENEX for PPM households and, therefore, low income households is substantially lower. Applying the correction means the time trend for PPM households' ENEX becomes closer to that for the Direct Debit and Standard Credit payment methods.

7 Deller and Waddams Price (2018a)

8 For example, in summer months, due to limited heating requirements, a top up on a gas PPM might last more than two weeks. However, evidence presented in Deller and Waddams Price (2018a) suggests this is only true for a small proportion of the observations.

9 Waddams et al (2001) and Mummery and Reilly (2010).

10 Table 2.2.1 and Table 2.3.1, Statistical data set: Annual domestic energy bills, Department of Business, Energy and Industrial Strategy, available at: https://www.gov.uk/government/statistical-data-sets/annual-domestic-energy-price-statistics

11 Deller and Waddams Price (2018a) provide further methodological detail.

Figure 2 Median annual energy expenditure by electricity payment method (PPM corrected and uncorrected)

(Data: Living Costs and Food Survey and precursors)[12]

3 Alternative Fuel Poverty Metrics

Our quantitative analysis of FP uses two datasets. First, the corrected LCF data outlined above are used to produce FP rates based on reported ENEX to compare with official FP statistics using 'required' ENEX[13] in England. Second, the British Household Panel Survey (BHPS) is used to compare FP indicators recording householders' perceptions of in-home warmth with indicators based on reported ENEX[14] across the UK.

Both analyses consider two expenditure-based FP indicators which have constituted the official English FP indicators.[15] The 10% indicator identifies a household as FP if ENEX exceeds 10% of household income. The Low Income-High Cost (LIHC) indicator identifies a household as FP if ENEX lies above median ENEX and household income, after the deduction of ENEX, lies below 60% of median income. Further detail on these indicators is provided in section 1.1 of Chapter 5.

3.1 Reported ENEX can give higher FP rates than required ENEX

Official FP statistics are based on 'required' ENEX, i.e. the estimated ENEX required to maintain a specified temperature within a dwelling. Much of the FP literature[16] assumes that FP statistics using

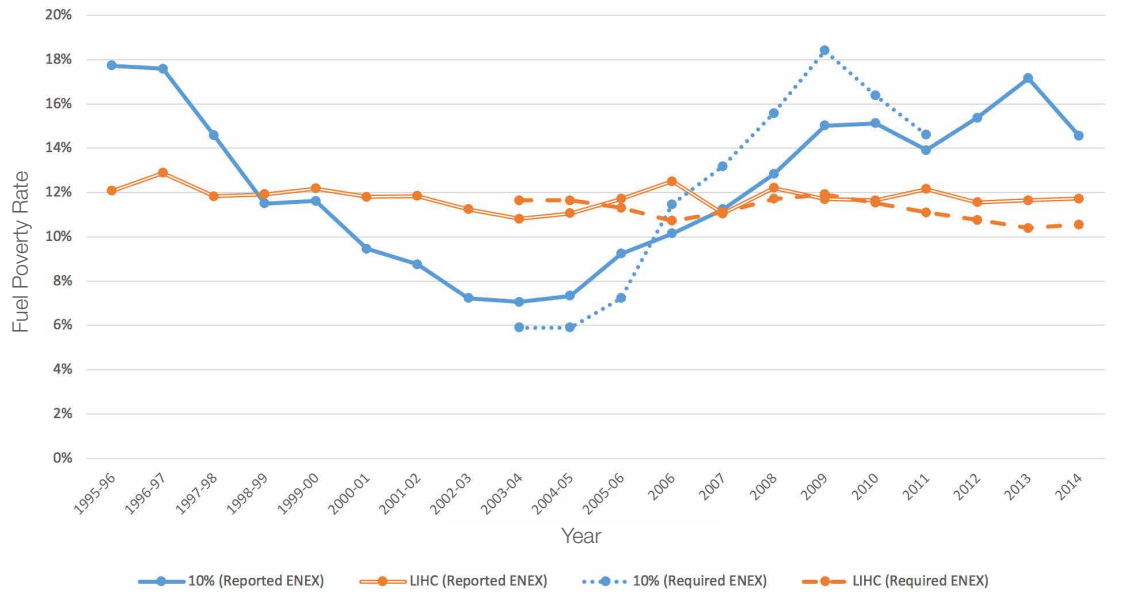
12 Deller and Waddams Price (2018a)
13 Deller and Waddams Price (2018b)
14 Deller, Turner and Waddams Price (2019)
15 Although the official indicators are based on required ENEX.
16 For example, Liddell et al (2012) and Thomson et al (2017).

reported ENEX under-report FP because households facing affordability pressures limit their ENEX by 'cutting back' on their energy use, e.g. reducing heating, not using lights and batch cooking etc. (see boxes 1 and 3 in Chapter 5). However, using the corrected LCF data, Figure 3 shows that the central estimate of the FP rate based on reported ENEX is sometimes higher than that based on required ENEX. Some earlier analysis which concluded reported ENEX under-reported FP relative to required ENEX was likely affected by the PPM measurement issue which reduced apparent expenditure for many low income households.[17] The estimated 10% FP rate based on reported ENEX exceeds the rate based on required ENEX when energy prices were low, but the reported ENEX FP rate is below the required ENEX FP rate when energy prices were higher. This changing relationship probably reflects a constant energy consumption being assumed under required ENEX, while reported ENEX reflects reductions in households' energy consumption when prices increase.

Figure 3 also illustrates the relatively constant rate over twenty years of LIHC FP calculated from reported ENEX. This limited fluctuation illustrates that the headline LIHC FP rate is not particularly useful as an indicator of changing energy affordability pressures through time, i.e. it does not respond to energy price fluctuations. This lack of response is inherent in defining LIHC FP relative to the position of average households.

Figure 3 Estimates of English fuel poverty rates using reported and 'required' energy expenditures, 1995-96 to 2014

(Data: Reported ENEX FP – Living Cost and Food Survey and precursors[18], Required ENEX FP – Department for Energy and Climate Change[19])



17 In particular, Hirsch et al (2011) and DECC (2014). DECC (2015), using data from 2013 (i.e. unaffected by the measurement issue), shows little evidence of under-reporting (relative to required ENEX).

18 Deller and Waddams Price (2018b)

19 10% metric: Trends in Fuel Poverty, England, 2003-2011, 10% Definition, Department for Energy and Climate Change (DECC), https://www.gov.uk/government/statistics/trends-in-fuel-poverty-england-2003-to-2011 (last accessed 13.08.18); LIHC metric: Trends in Fuel Poverty, England, 2003 to 2014, Department for Energy and Climate Change (DECC), https://www.gov.uk/government/statistics/fuel-poverty-trends-2003-2014 (last accessed 13.08.18).

3.2 The English Housing Survey should record reported ENEX

Figure 3 considers the aggregate FP rate, the relationship between reported and required ENEX FP rates for specific subgroups of households varies by the characteristics (e.g. age, tenure) used to segment households. A potentially notable finding is that the reported ENEX FP rate for those in social housing is noticeably above the required ENEX FP rate for all years considered (see Figure 3 in Chapter 5).[20] Since social housing dwellings have the highest average energy efficiency ratings (see Figure 2 in Chapter 5), this specific result could indicate the model used to calculate required ENEX over-estimates the ability of energy efficiency interventions to limit ENEX.

The more general mixed relationship between reported and required ENEX FP rates when households are disaggregated could be consistent with the random errors associated with any modelling process. FP statistics may be particularly prone to influence by modelling errors as they focus on the upper tail of the ENEX distribution rather than average ENEX. In addition to modelling how building characteristics map into energy consumption, required ENEX involves assumptions (of varying importance) regarding: (i) the temperature targeted, i.e. individuals' preferences are not considered; (ii) the pattern of heating, occupancy and energy consumption through time; and (iii) the price of energy. For these reasons we believe the term 'modelled ENEX' is more transparent than 'required ENEX'.

Nevertheless, a limitation of the above comparisons should be noted: the reported and required ENEX figures are from different surveys,[21] so it has not been possible to compare reported and required ENEX for individual households. Since the results raise questions about the required ENEX methodology it would be valuable to obtain data enabling definitive comparisons. To enable such comparisons, we encourage the addition of appropriate questions to elicit reported ENEX and energy consumption to the English Housing Survey,[22] the survey used to produce the official required ENEX FP statistics.

3.3 Perception-based and ENEX-based FP indicators show limited overlap

The analysis in sections 3.1 and 3.2 presumes that the 10% and LIHC metrics have clear meanings in terms of households' real-world experiences. BHPS data record self-reported assessments of heating adequacy and enables a comparison between these perception-based FP indicators and the 10% and LIHC FP indicators at the individual household level. The very limited overlap between the different indicators raises fundamental questions about what the indicators identify and how best to operationalise the concept of FP. In this sub-section all 10% and LIHC FP figures are based on reported ENEX.

The BHPS data offer three FP-relevant perception-based indicators:

1 Inability to keep home adequately warm;
2 Inability to afford to keep home adequately warm;[23]
3 Accommodation lacks adequate heating facilities.

Indicator 2 seems most closely aligned to traditional notions of FP measurement.

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20 Reported ENEX FP exceeds required ENEX FP in 2013 and 2014 as well as earlier years, hence the relationship is not just the result of the PPM correction leading to ENEX prior to 2013 being 'upper bounds'.
21 The differences in Figure 3 could be influenced by methodological differences between the surveys.
22 Moore (2012) has previously advocated this.
23 Households were only asked whether they could not afford adequate warmth after answering that they were unable to keep their home adequately warm; this may influence Figures 4-7.

Figure 4 reports the percentage of households identified by each FP indicator in the unweighted BHPS data.[24] Figure 4 is not intended to provide accurate estimates of FP rates for the UK population as a whole, rather it illustrates what drives the lack of overlap between the different indicators shown in Figures 5-7. The higher rate of LIHC FP in Figure 4 compared with Figure 3 results from the BHPS over-sampling households in the devolved administrations, areas where households tend to have higher ENEXShr than in England.

Figure 4 Unweighted rates of alternative fuel poverty indicators in our analysed BHPS sample covering the whole of the UK, 2001-02 to 2008-09

(Source: British Household Panel Survey)[25]

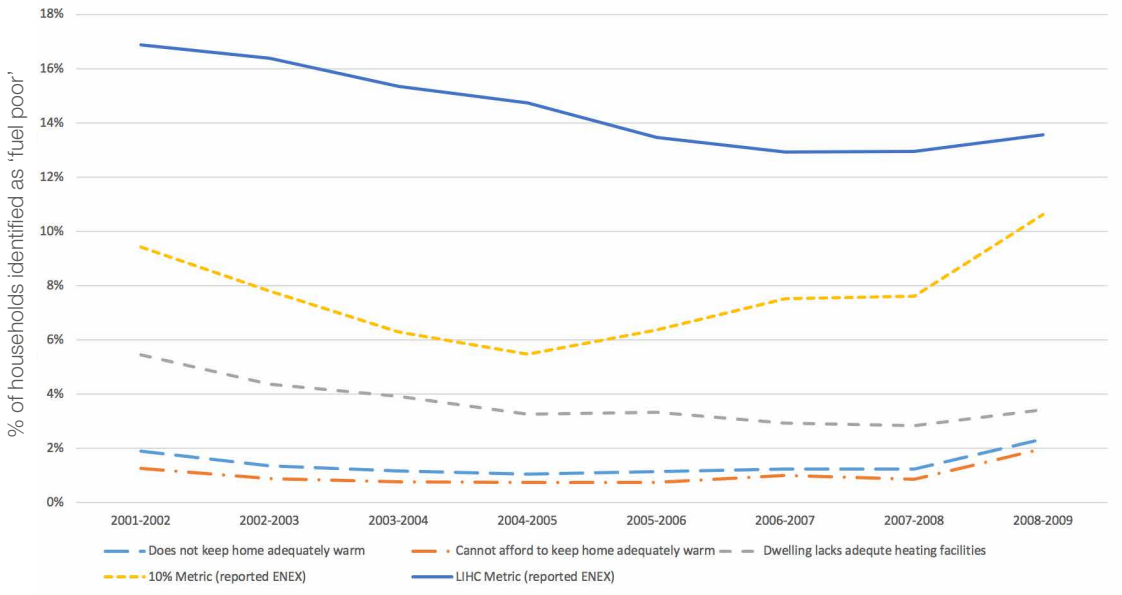


Figure 4 shows striking differences in the proportion of analysed households identified as FP by each of the ENEX-based and perception-based indicators. Across the period, the highest proportion of households reporting an inability to afford adequate warmth is 2.0%, compared to a peak of 10.6% for 10% FP and 16.9% for LIHC FP. That so few households report an inability to afford adequate warmth raises questions about the phenomenon being identified by the 10% and LIHC metrics.

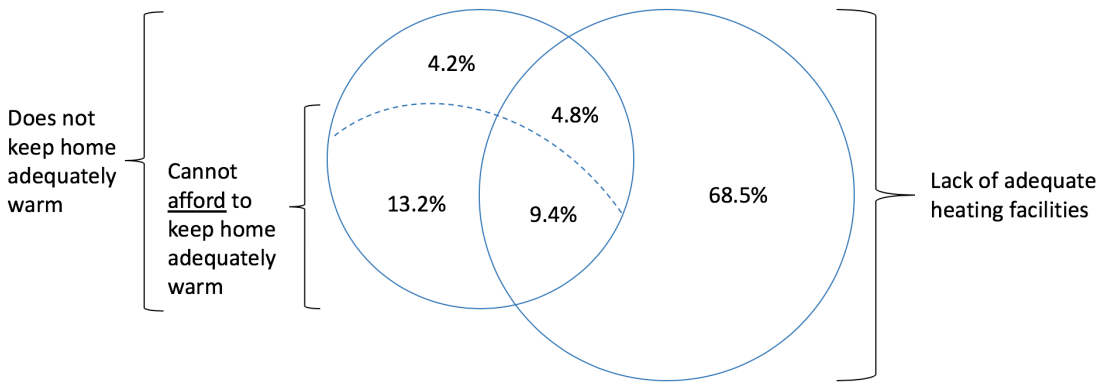
24 Figures 4-7 use an unbalanced panel, i.e. households were interviewed in multiple years, but may not have been interviewed in all years. The time trends in Figures 4, 6 and 7 may be influenced by attrition, i.e. households dropping out of the sample.

25 Deller, Turner and Waddams Price (2019)

The differences between the three perception-based FP rates should also be noted, as they show the effect of wording on the prevalence of FP suggested by perception-based indicators. The differences also illustrate how householders perceive access to heat. Combining data across 2001-02 to 2008-09, Figure 5 shows 68.5% of those reporting either a lack of adequate heating facilities or an inability to keep their home warm only reported a lack of adequate heating facilities; in other words, most households reporting inadequate heating facilities thought they were able to keep adequately warm. Also, of those reporting an inability to keep their home adequately warm, 28.4% indicated that this was for reasons other than affordability.

Figure 5 A Venn diagram of the three perception-based fuel poverty indicators considered in Deller, Turner and Waddams Price (2019), combining data from 2001-02 to 2008-09

(Source: British Household Panel Survey)[26]



KEY: Percentages calculated as a proportion of all those reporting 'lack of adequate heating facilities' or 'does not keep home adequately warm'

Figures 6 and 7 provide further detail on the overlap between the ENEX-based and perception-based indicators. Figure 6 reports the percentage of households identified as 10% or LIHC FP who report each of the perception-based indicators. The extent of overlap with the ENEX-based metrics is remarkably low: in all years, over 90% of households judged as FP according to the 10% and LIHC indicators do not self-identify as suffering inadequate warmth.

Figure 7 shows the percentage of households reporting each perception-based FP indicator who are also identified as 10% or LIHC FP. Compared to Figure 6, a noticeably higher proportion of perception-based FP households are identified as ENEX FP, although, in all cases, still only a minority of perception-based FP households are also identified as ENEX FP. With the exception of 2001-02, at least 60% of those reporting an inability to afford to adequate warmth are not identified as FP by the 10% or LIHC indicators.

Figure 6 Percentage of 10%/LIHC fuel poor households reporting perception-based fuel poverty indicators,[27] 2001-02 to 2008-09

(Source: British Household Panel Survey)[28]

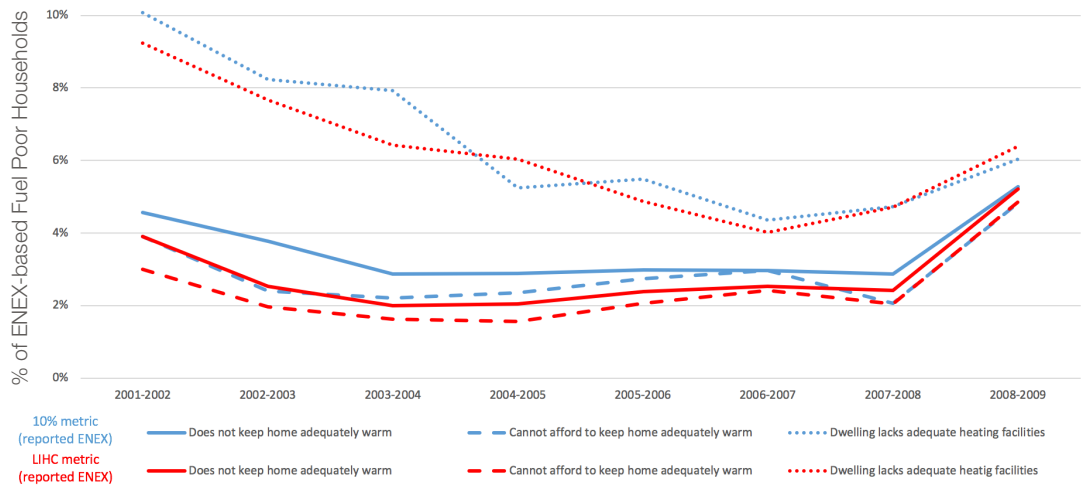
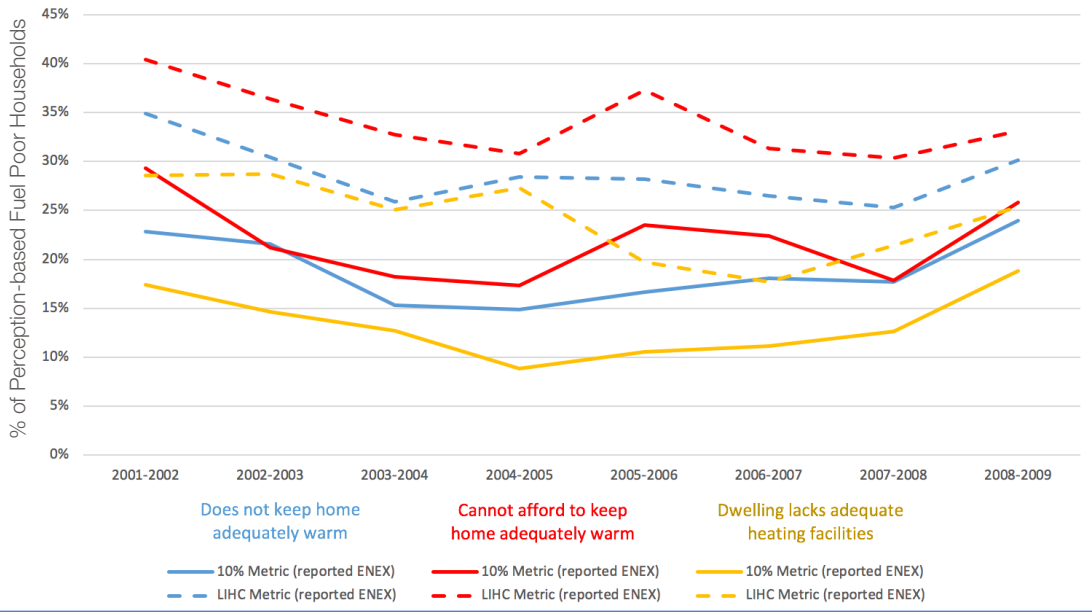


Figure 7 Percentage of perception-based fuel poor households identified as 10% / LIHC fuel poor,[29] 2001-02 to 2008-09

(Source: British Household Panel Survey)[30]



27 For example, the solid blue line represents the percentage of households in 10% FP that report that they cannot keep their home adequately warm.

28 Deller, Turner and Waddams Price (2019)

29 For example, the solid red line indicates the percentage of households reporting that they cannot afford adequate warmth who were identified as being in 10% FP.

30 Deller, Turner and Waddams Price (2019)

Furthermore, regression results[31] indicate that different types of households are associated with each FP indicator. In particular, there are notable differences in the associations between older households and the alternative FP indicators. Compared to a household headed by someone under 65 (and after controlling for a large range of other factors), a household with a head aged 75 or over is more likely to be LIHC FP, just as likely to be 10% FP and, in some specifications, less likely to report an inability to afford adequate warmth.

3.4 Recording temperature preferences and in-home temperatures seems key

Since the FP results above use reported ENEX, the results might suggest the ENEX-based and perception-based indicators pick up different aspects of FP. The ENEX-based indicators could be identifying households who achieve adequate heat but at the cost of reduced consumption of other goods, while households reporting an inability to afford adequate warmth could be identifying households restricting their energy consumption below a 'healthy' level to afford other essential products. However, this interpretation relies on several assumptions.

A central problem is that we know neither the temperatures achieved by households nor their temperature preferences, in particular we do not know whether ENEX FP households achieve higher in-home temperatures than those reporting an inability to afford adequate warmth. Perhaps those reporting an inability to afford adequate warmth consider a higher temperature as 'adequate' than other households? Alternatively, if expectations of in-home warmth have increased in recent decades, perhaps some older individuals view lower temperatures as 'adequate'? Psychological factors affecting whether a household views a given set of physical circumstances positively or negatively, and the willingness of respondents to report negative experiences, will also influence perception-based FP indicators.

Information about in-home temperatures and householders' temperature preferences would help to illuminate: (i) the relationship between different FP indicators, and (ii) the policy interventions offering the greatest welfare improvements. Without temperature information, recommendations about particular FP indicators being more appropriate than others require significant assumptions. Equally, we recognise that in-home temperature recordings face their own methodological challenges.

Smart thermostats[32] may present a new opportunity to obtain temperature data at a large scale, and could provide both frequent temperature recordings and information on the temperatures which households are seeking to obtain. Moreover, some smart thermostats are specifically targeted at social housing providers,[33] whose tenants likely have a high risk of energy affordability challenges. However, smart thermostats do not offer a panacea for research: some households (e.g. private renters) may be unlikely to receive one and smart thermostats themselves are designed to lower the cost of achieving a given temperature.

31 Deller, Turner and Waddams Price (2019)
32 These are different to smart meters.
33 For example, see Switchee, http://switchee.co/ (last accessed 13.08.18)

4 Maximising Insights from Data

This chapter has illustrated the benefits of revisiting data sets which have been collected for another purpose; secondary data analysis provides important insights into both potential data problems and the detail of fairness and affordability regarding energy consumption. A clear expectation of sharing survey data can influence research agendas and stimulate analysis providing further information to improve regulatory policy and delivery. One underused source of data has been the surveys regularly commissioned by Ofgem[34] and other economic regulators, which each represent a significant investment of time and public money. Making these surveys routinely available would: (i) enable groups with different perspectives to contribute to analysis and knowledge; (ii) harness the time and skills of external groups to conduct in-depth analysis; (iii) increase the transparency of the evidence supporting regulation; and (iv) identify potential data collection improvements.

An example of this potential is shown by our research[35] suggesting additional questions for Ofgem's MSB survey in Chapter 4. Analysis of the MSB survey data could have yielded richer results if the energy supplier indicator had not been redacted, and more research to inform regulators' policy making could be available if the need to seek special permission to access this type of data can be avoided. We note that Ofcom places the raw data from an equivalent survey covering the communications sector on its website with no apparent restrictions[36] and we welcome Ofgem's data services and supplier hub projects. To harness external contributions to regulatory knowledge, we suggest that economic regulators adopt a default presumption, similar to the requirements placed on researchers funded by the Economic and Social Research Council (ESRC), to share data, where possible, via the UK Data Archive. The following procedures would facilitate such a policy:

1 All survey datasets commissioned by economic regulators are publicly listed and a brief description provided (metadata);
2 Suitably anonymised raw data are shared whenever possible;
3 Where data cannot be shared, a detailed explanation of reasons for the inability to share is provided.

This procedure would provide transparency about the survey evidence commissioned by regulators, and the non-sharing of publicly funded data would be justified to external parties. While greater openness with data may increase challenge in some areas of regulation, we hope that such a challenge would exert a positive influence on the quality of regulation. An open data policy could also increase the transparency and legitimacy of the regulatory process.

5. Conclusion

This chapter has explored a range of data and measurement issues identified in our research regarding the available evidence on fairness in the retail energy market. While this chapter and Chapter 4 highlight the potential gains from additional data collection, all the quantitative evidence documented in this report is based on analysis of pre-existing datasets. Significant insights can be obtained from returning to old datasets and thinking creatively about whether they can answer questions not envisaged by their designers. This experience drives our conclusion that open data-sharing should enable more informed decision making.

34 For example, since 2012 Ofgem has commissioned at least five surveys covering MSB engagement.
35 Deller and Fletcher (2018).
36 'SME Consumer Experience Research 2016 Raw Data' available at: https://www.ofcom.org.uk/research-and-data/multi-sector-research/general-communications/sme-research (last accessed 13.08.18)

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