Fuel poverty, household income and energy spending

An empirical analysis for Australia
using HILDA data

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Brotherhood
of St Laurence

Working for an Australia free of poverty

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Summary

Since 2007 household energy prices have risen significantly across Australia. As energy prices have increased, so has concern over the impact on households' economic and social wellbeing. This study explores Australian households' expenditure on energy and their experience of fuel poverty (or energy hardship as it is commonly referred to in Australia). This study is significant because while fuel or energy poverty has been studied extensively in Europe, there have been limited empirical studies in Australia. The patterns of fuel poverty are important to understand in order to:

1 **Better understand and identify energy-related deprivation:** Households in energy poverty face a specific form of material deprivation. In order to address it, we need to understand the different types of fuel poverty and identify those who experience it.
2 **Enable more effective interventions to reduce fuel poverty, including better targeting of government and utility expenditure:** Across Australia millions of dollars are spent on energy concessions and other energy-related assistance. A better understanding of fuel poverty provides a basis to assess whether this expenditure is well directed to the groups most in need.

A study of fuel poverty may also have other benefits. Fuel poverty, and particularly difficulty paying energy bills, may provide an early indicator of other forms of hardship (Allen Consulting Group 2004). Moreover, a better understanding of fuel poverty may also remove one of the barriers to reform in the Australian energy market. When high levels of fuel poverty exist, some useful reforms are jeopardised because of the implications for vulnerable consumers. Careful analysis of fuel poverty can enable policies to be developed which mitigate the impacts of reforms on these groups.

Research aim

The main aim of this project is to improve our understanding of household fuel expenditure (that is, expenditure on energy excluding transport) and fuel-related hardship in Australia using data from the Household, Income, and Labour Dynamics in Australia (HILDA) survey.

Our objectives are twofold. First, we document recent trends in household fuel expenditure and show how fuel expenditure relates to the socioeconomic status of families, measured by two alternative indicators of economic wellbeing: household disposable income and a multidimensional measure of social exclusion.

Second we quantify and characterise fuel poverty in Australia. Despite the growing attention that fuel poverty has received in high-income economies, no consensus has been reached on how to define and measure the extent of fuel poverty. Definitions are important because they allow us to measure the extent of the problem and subsequently to define appropriate solutions (see DECC 2013).We consider several alternative definitions of fuel poverty. These definitions can be grouped into two broad categories, *income–expenditure* and *consensual* definitions. Included in the *income–expenditure* definitions are those that identify fuel-poor households by comparing income and fuel expenditure, and the low income–high cost definition proposed by Hills (2012). This category also includes the absolute and relative versions of the cost-to-income definitions (Boardman 1991; Moore 2012) that characterise as fuel-poor those households whose fuel costs exceed a certain threshold. We compare results based on income–expenditure definitions with those from a second category of *consensual* definitions based on households' self-reported ability to heat their homes and pay energy bills on time.

Key findings

1. Fuel expenditure and socioeconomic status

Expenditure on fuel is increasing, but the proportion of income spent has remained constant

Our estimates for the period 2005–2011 suggest a significant increase in fuel expenditure by Australian households.

Despite this increase we find that the proportion of income spent by households on fuel in 2011 is not significantly different from that in 2005. One possible explanation is that the rise in energy prices was at least partially offset (on average) by the increase in household disposable incomes observed during that period. This result must be interpreted with caution as HILDA participants are likely to under estimate their annual expenditure on energy bills by between 13 and 20 per cent (Wilkins & Sun, 2010).

Households on low incomes spend more of their income on fuel than those on high incomes

Similarly to previous analyses available in the literature, we find that while fuel expenditure increases with income, the percentage of income spent on fuel clearly declines as income increases. That is, households with a low income spend a larger share of their incomes on fuel than higher income households. In 2011, those in the bottom decile of the income distribution spent on average nearly 7 per cent of their annual incomes on fuel, whereas the richest decile spent slightly more than 1 per cent of their incomes. This was similar to the pattern in 2005.

A similar relationship is found when the multidimensional measure of social exclusion is used instead of the income indicator: the most excluded households spend less in absolute terms on fuel than other groups, but in relative terms they spend a larger share. In 2011, the most socially excluded households spent 4.5% of their income on fuel and the least excluded households only 2%. This too was similar to the pattern in 2005.

2. Alternative conceptions of fuel poverty in Australia

Different definitions of fuel poverty identify very different groups of fuel-poor households

Our analysis of HILDA data using five definitions of fuel poverty shows that the definition chosen plays a crucial role in quantifying the prevalence of fuel poverty and characterising fuel-poor households. We find important differences between the *income–expenditure* and the *consensual* definitions regarding the prevalence of fuel poverty in Australia. In addition, we find very little overlap between the households identified as fuel-poor using consensual concepts of fuel poverty (based on households' self-reported ability to heat their homes and to pay bills[1] on time) and the households identified as fuel- poor using the *income–expenditure* definition.

Despite these differences, our analysis indicates that the incidence of fuel poverty remained largely unchanged between 2005 and 2011, and this result is robust to the fuel poverty definition used. This finding is surprising, and should be treated with caution, as significant contrary evidence exists. For example, the rate of disconnections showed marked increases in all jurisdictions (except the ACT) between 2009–10 and 2010–11 (ESC 2014, p. 27). Demand for energy-related support from community organisations has also reportedly increased.

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[1] The available HILDA data combines inability to pay electricity, gas and phone bills on time.

Selected characteristics of the people in fuel poverty as identified by different definitions are outlined below.

Age profiles of the fuel-poor differ according to the definition used.

- Using the *income–expenditure* measures, more than one-third of the households identified as fuel-poor have a head aged 65 years or above. Using the *consensual measures*, more than 45 per cent of fuel-poor households are headed by someone aged between 35 and 54 years.

Most fuel-poor households are small.

- The share of fuel-poor households that have only one or two members is always above 50 per cent, regardless of the definition considered. Couples with no children account for more than one-quarter of the fuel-poor when these are identified using *income–expenditure* definitions. Single-person households have large representation among the fuel-poor, especially using the relative cost–income ratio[2] (52 per cent of this group) and the unable to heat the home indicators (40 per cent).

However, households defined as fuel-poor because they could not pay their bills on time tend to be larger than those in other fuel-poor groups.

- More than one-third of those households that could not pay their bills on time have three or four members, which reflects the larger proportion of couples with children in this group relative to other fuel poverty indicators.

Home ownership status of fuel-poor households differs dramatically across definitions.

- More than 45 per cent of those identified as fuel-poor by the *income–expenditure* group of measures are outright home-owners and at least another 15 per cent are paying off a mortgage.

- Private renters are the largest group among those who are unable to heat the home (37 per cent) or cannot pay their bills on time (42 per cent).

Regardless of the definition chosen, households with a member with a disability are clearly overrepresented among those experiencing fuel poverty.

- These households account for more than 50 per cent of the fuel-poor regardless of the definition, and this percentage goes up to more than 60 per cent in the case of the low income–high expenditure and the unable to heat the home indicators.

Implications for policy

1 Identifying those most in need may require more than one indicator

From a policy point of view, a key question about fuel poverty definitions is the extent to which they are able to identify those who are most in need. However our robust wellbeing comparisons using income, social exclusion and household expenditure indicators reveal a complex picture about which definition identifies the households that are the 'neediest'.

To identify those fuel-poor households who are the poorest in terms of *income*, the low income–high cost or the absolute cost–income ratio definition are shown to be the best measures. If we want to identify those who are most *socially excluded*, there is no stand-out definition; the most suitable

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[2] The relative cost–income ratio we adopted (following Moore 2012) identifies as fuel-poor those households whose fuel costs as a share of income exceed twice the median cost-to-income ratio.

definition depends on the thresholds and indicators chosen. If we are concerned with households with the lowest household *expenditure*, those who are unable to heat their home are the most deprived.

As noted above, the different fuel poverty definitions captured very different groups of households. The following examples illustrate the difference in profiles of the fuel-poor using three definitions:

- **low-income households with high energy expenditure.** This group includes a high proportion of people over 65 who own their home and are out of the labour force. By definition a very high proportion are in the bottom income decile; and a high proportion are among the most socially excluded.

- **households who are unable to pay their bills on time.** This group includes a high proportion of single or dual parent households with one or more children, who are either renting or paying off a mortgage, and a high proportion of households with at least one person employed full-time. Among the groups identified by the five definitions of fuel poverty, this group has the most even spread of incomes, although it is still skewed towards those on low and middle incomes. A similar pattern is seen for social exclusion.

- **households who are unable to heat their home.** This group includes a high proportion of people who are aged 45–54 years, are lone parents or single, and are renting or paying off a mortgage. Almost half have one or more persons out of the labour force. A large proportion of these households are in the bottom two deciles of the social exclusion scale.

Given the limited overlap between the groups of fuel-poor households, if one definition of fuel poverty were adopted for policy purposes many people who would be in energy hardship by another definition would miss out. For example, if fuel poverty were defined as inability to pay bills on time, many households on low incomes with high energy expenditure, and many households who are unable to heat their homes, would be excluded. The results of this study suggest that, if used in isolation, none of the definitions tested would adequately cover the diverse households who experience fuel poverty in Australia.

2   Fuel poverty in households with a member with a disability needs more attention

Using all definitions of fuel poverty, households with at least one person with a disability are overrepresented. Further attention needs to be given to understanding the drivers of fuel poverty within this group, and the opportunities to address them. While not the focus of this study, the drivers may include lower income levels, higher energy usage due to an above-average proportion of time spent at home, and increased energy needs related to specific disabilities.

Consideration should also be given to increasing assistance to improve energy affordability for this group.

3   A pluralist approach to energy assistance is needed

It is apparent that energy assistance programs (including energy concessions) need to provide for the diverse types of households who face fuel poverty. While no attempt was made to assess the assistance currently provided to the various groups, the type of assistance needed is likely to vary with the type of fuel poverty faced (including inability to pay bills on time, inability to heat homes, and low income but high energy costs) and the causes. Further analysis of the causes of the different types of fuel poverty is also warranted.

This study highlights the challenge facing policy makers concerned with reducing fuel poverty (or energy-related hardship). Policies to address fuel poverty need to address different groups of households who are struggling with different dimensions of fuel poverty. The different dimensions of fuel poverty all have an impact on householders' material wellbeing. Yet the causes of fuel poverty, and therefore the potential solutions, are likely to differ in the different groups. At the same time, policy makers will need to make determinations about who is most in need of support. This study provides important information to inform those choices.

1 Introduction

Since 2007 household energy prices have risen significantly across Australia (see Garnaut 2011). As energy prices have increased, so has concern over the impact on households' economic and social wellbeing (see, for example, Chester 2013; Nance 2013). Indicators of energy-related stress, such as electricity or gas disconnections and participation in energy hardship programs have also risen in most Australian jurisdictions (see ESC 2014, pp. 30–1).

Fuel or energy poverty in Australia and internationally

Over the past four decades 'fuel poverty' has received increasing attention in high-income economies, especially in the United Kingdom where there has been an intense debate about the concept and its empirical application (see Hills 2012; Moore 2012). To date, however, no consensus has been reached on how to define and measure the extent of fuel poverty.

By contrast, the concept of fuel or energy poverty has received minimal direct attention in Australia. In their place the Australian debate has been couched in terms of cost of living pressures, energy affordability or energy hardship (see, for example, AEO et al. 2013). Although there has been some shift in recent times (see for example Chester 2013, Nance 2013), the terms fuel or energy poverty are still not commonly applied in the Australian context. While the terms may not be in general usage, the underlying issues are common to the Australian situation.

Choosing between the terms 'fuel poverty' and 'energy poverty' is difficult in the Australian context. Fuel poverty is extensively applied in discussions in northern hemisphere cold climates, where households require fuel for heating. More recently, writers such as Li et al. (2014) have distinguished between energy poverty as access to energy (especially in an international development context) and fuel poverty as relating to affordability, the topic of this paper. We do however, recognise the complexity of using fuel poverty in Australia, where the word fuel is more often associated with cars and other vehicles. Further, many Australians live in climate zones where fuel for heating is less important, and high energy bills can instead restrict people's access to cooling, with implications for comfort and health. The term energy is also applied more broadly to domestic uses other than simply heating or cooling. This has led to a number of writers, notably Chester (2013), using the term energy poverty in the Australian context. We have chosen, nevertheless, to align the paper with the international debate and use the term 'fuel poverty'.

Dimensions of fuel poverty

In this paper, we are interested in understanding the different types of energy-related stress, and how well the measures of fuel or energy poverty capture the households experiencing hardship. The types of energy-related stress that households experience include:

1 Being unable to pay energy bills (or energy billing hardship)

Households who are unable to pay their energy bills eventually fall into arrears with their energy retailer. Some households who cannot pay their bills end up on their energy retailers' hardship programs, which aim to assist people address their billing issues.[3] Failure to pay energy bills can also result in disconnection, a phenomenon which is increasing in most Australian jurisdictions

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[3] However, anecdotal reports also suggest some energy retailers make it difficult for customers to access their billing hardship programs by poor customer service practices, which could easily be addressed by better training and higher standards for frontline staff (Claire Maries [Consumer Action Law Centre], pers. comm.).

(see, for example, ESC 2014). Simshauser et al. (2011) identified that 'family formation' households, who on average have one or two children, are a sizeable segment of the households unable to pay their bills. For social support and government agencies, difficulties paying energy or other utility bills are of particular interest because they may signify broader financial disadvantage; therefore addressing them may provide an opportunity for referral and support with other issues (Allen Consulting Group 2004).

2   Restricting energy consumption to the detriment of health and wellbeing

Some households restrict their energy consumption to the detriment of their health or wellbeing, but pay their energy bills and therefore do not show up in billing hardship statistics. This form of hardship is often hidden and there is relatively little empirical data on households such as these who are facing material deprivation, either directly as a result of constraining their energy consumption or indirectly through doing without other goods or services. Chester (2013), however, has outlined the trade-offs some of the most disadvantaged households are forced to make between paying their energy bills and using the money to purchase food, pay the rent or pay for a school excursion.

3   Having relatively low income *and* spending a relatively high proportion of income on energy

Households with low incomes but high energy expenditure are of particular interest, as they have limited means yet they are using a higher proportion of that income on energy expenditure. The reasons for these households' high spending on energy are not the focus of this study; however, factors may include poor housing, inefficient appliances, poor energy literacy, above-average hours spent at home, sub-optimal energy retail contracts, many members on low incomes, or needs associated with health or disabilities. It is likely that some of these households are constraining their lifestyle elsewhere in order to pay their energy bills, or risk falling into energy billing hardship.

Assistance that partially offsets fuel poverty

In Australia, households' experience of fuel poverty has been partially offset by various forms of energy-related assistance offered by state and territory governments, the Commonwealth and energy retailers. While there are variations in the amount and eligibility, the primary types of assistance include ongoing means-tested discounts on energy bills, one-off emergency relief grants, discounts for households in special circumstances (such as a member requiring life support), and support through a mandated energy hardship program run by an energy retailer (see Deloitte 2013 for a more detailed list of support). A number of commentators have expressed concerns that the current system may not provide adequate coverage, nor provide the depth of support required (see, for example, Deloitte 2013; IPART 2010)[4].

The purpose of this study is not to undertake a detailed review of the energy assistance programs. However, understanding who is in energy poverty may provide a basis to assess the effectiveness of the available energy assistance in addressing energy poverty, particularly for those most in need. Our research is a step in that direction as it characterises different groups of fuel-poor and compares the levels of disadvantage of these groups using various welfare indicators.

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4 IPART (2010), for example, identified a small but important group of people in New South Wales who do not qualify for a state energy concession but are likely to face ongoing energy bill stress.

2 Data sources and variables

For our analysis of fuel poverty we use data from the Household, Income, and Labour Dynamics in Australia (HILDA) survey. Initiated in 2001, the HILDA survey is a nationally representative survey that includes detailed socioeconomic information for households in Australia, including data on disposable income and on fuel expenditure.[5] Since the first four waves of HILDA do not report fuel expenditures, we use data from waves 5 to 11 covering the period 2005–2011. Each wave contains data for about 7,000 households and their family members which, with appropriate weighting, can be used to make inferences at the population level.

The unit of analysis we use in this paper is the household. Our first goal is to investigate the relationship between households' socioeconomic status and fuel expenditure. Since wave 5, HILDA participants have been asked about various household expenses including their expenditure on 'electricity bills, gas bills and other heating fuel (such as firewood and heating oil) incurred over the last 12 months'.[6] These responses we use as a measure of fuel expenditure. For the socioeconomic status of households we use two different welfare indicators. Results based on the standard income approach in which income is the only relevant variable for defining household wellbeing are compared with those derived using the multidimensional 'social exclusion' measure developed by the University of Melbourne (UoM) and the Brotherhood of St Laurence (BSL) to measure multiple disadvantage in Australia (Scutella et al. 2009a, 2009b).

The income variable considered in the analysis is household disposable income. This is the sum of wages and salaries, business and investment income and other private income, plus pensions, allowances or benefits provided by the Australian government, received by any household member, minus personal income tax payments made during the financial year.

The UoM & BSL measure of social inclusion constitutes a multidimensional approach to the measurement of welfare. This measure builds on the Laeken Indicators and the Bristol Social Exclusion Matrix developed in Europe and the United Kingdom respectively, and incorporates information on 30 indicators from seven different domains: material resources, employment, education and skills, health and disability, social connection, community, and personal safety. A summary measure of social exclusion is derived from these indicators using a sum-score method. This variable takes values in the interval [0,7], where 0 corresponds to the deepest level of social exclusion.[7] A list of the welfare indicators in each domain is presented in Appendix A.

For the welfare comparisons of the different fuel-poor groups we also use information on overall household expenditure. From the HILDA data we construct a broad measure of annual expenditure which apart from fuel expenditures also includes the amounts spent on groceries, clothing and footwear, public transport, motor vehicle fuel, private health insurance, home and car insurance, medicine prescriptions and pharmaceuticals, home repairs and renovations, motor vehicle repairs and maintenance, education fees, mortgage repayments and rents, telephone rent and calls, internet, alcohol, cigarettes, and meals out of home.

In some parts of our analysis, income and fuel-expenditure variables are adjusted for differences in needs across households by means of equivalence scales. While there is an extensive literature on

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[5] For a detailed description of the HILDA sample see Wooden and Watson (2007).
[6] Note this variable does not include the amount spent on fuel for vehicles, which is collected separately.
[7] To aid the exposition of the results the original UoM & BSL measure was transformed so that higher values of the measure indicate less exclusion.

the use of these scales and its implications for income distribution and poverty analysis, the issue of whether fuel expenditures should be adjusted or not, and the implications of equivalisation, have received less attention and are less clear. We adjust income values using the modified OECD scale widely used in welfare distribution analysis, which computes household needs as the sum of weights for all household members, with a weight of 1 assigned to the first adult, 0.5 to each additional adult and 0.3 to every household member under 15 years of age. For fuel expenditure, we consider the set of equivalisation factors proposed in Hills (2012) to analyse fuel bills, which assigns a weight of 1 to couples without dependent children, 1.15 to couples with dependent children, 0.94 to lone parents, 0.82 to singles, and 1.07 to other multi-person households. We check the robustness of our empirical findings using the parametric family of scales proposed by Buhmann et al. (1988) for income distribution analysis according to which household needs are given by

$$E = N^{\theta},$$

where N is the household size and θ is the measure of economics of scale within the household.

Households with non-positive income and households whose estimated share of income spent on fuel is above 50 per cent are removed from the HILDA sample. The second group comprises mostly households reporting very low annual incomes and high and unusual expenditure values. This results in the elimination of 0.6–1.5 per cent of households in the sample, depending on the wave.

3 Findings: fuel expenditure and socioeconomic status

We start the analysis of fuel poverty by looking at the relationship between average household fuel expenditure and socioeconomic status (SES). Figure 3.1 below shows the average fuel expenditure for different groups when households are ranked using two alternative SES measures: their income (panel a) and their level of social exclusion (panel b). Clearly there exists a positive relationship between the level of fuel expenditure and SES, regardless of how SES is defined. Thus, households with low incomes and households experiencing high levels of exclusion spend in absolute terms less on fuel than their well-off counterparts. Comparison of the gradients for the years 2005 and 2011 suggests that there was a general increase in the amount that households spend on fuel that affected all socioeconomic groups.[8]

Figure 3.1   Average fuel expenditure by socioeconomic status
a) Fuel expenditure vs income by decile
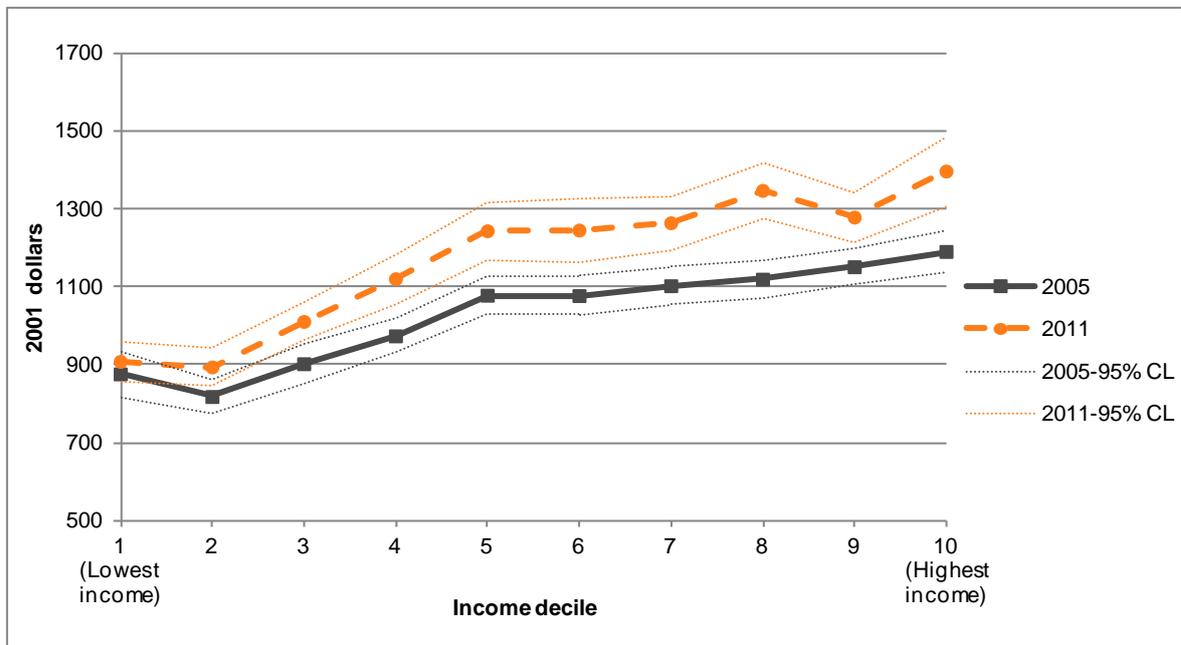
See notes below Figure 3.1(b)

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[8] Results from the robustness analysis, available upon request, show that this finding is robust to the use of different equivalence scales.

b) Fuel expenditure vs social exclusion by decile

Notes: CL = confidence limits
Fuel expenditure values equivalised using the factors proposed in Hills (2012) and expressed in 2001 dollars.
In figure a) households are grouped according to their equivalent incomes computed using the modified OECD equivalence scale.
Source: Authors' calculations using data from the HILDA survey

Fuel expenditure as a percentage of disposable income

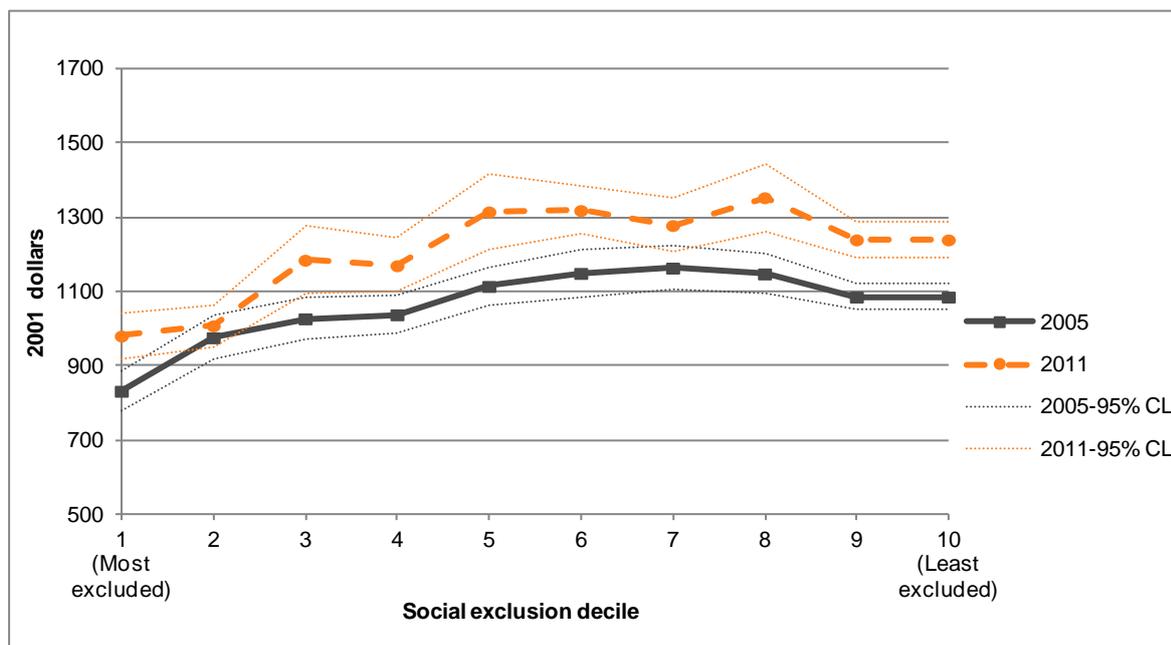Interestingly, however, we find that the rise in expenditure on fuel was (on average) compensated by an increase in incomes, so that the proportion of household income spent on fuel by the different groups barely changed over the period under analysis.

Figure 3.2 shows the average share of income spent on fuel for the different income and social exclusion groups. The curves for 2005 and 2011 are remarkably similar: for most income groups the proportion of income used to purchase fuel in 2011 was almost equal to that in 2005, and in the case of social exclusion a very small amount of variation is found among the bottom six deciles. The estimates presented in both figures show that fuel expenditure accounts for a larger share of income among low-SES households and this share declines for households higher up the SES ladder. This indicates that fuel expenditures have a larger impact on the budget of disadvantaged groups regardless of whether these groups are identified using an income measure or a broader measure that accounts for the multiple dimensions of disadvantage.[9] In 2011, those in the bottom decile of the income distribution spent on average nearly 7 per cent of their annual incomes on fuel, compared with the richest decile, who spent about 1 per cent. The gradient for social exclusion is flatter than the one for income. Thus, in 2011 the most excluded 10 per cent spent almost 5 per cent of their income on fuel, almost 2 percentage points less than those in the bottom decile of the income distribution.

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[9] Scutella et al. (2009b) and Azpitarte (2013) show that the overlap between the income-poor and the most excluded is far from perfect as many of those who are most excluded have incomes above the poverty line.

Figure 3.2   Average share of income spent on fuel by socioeconomic status
a) Share vs income by decile
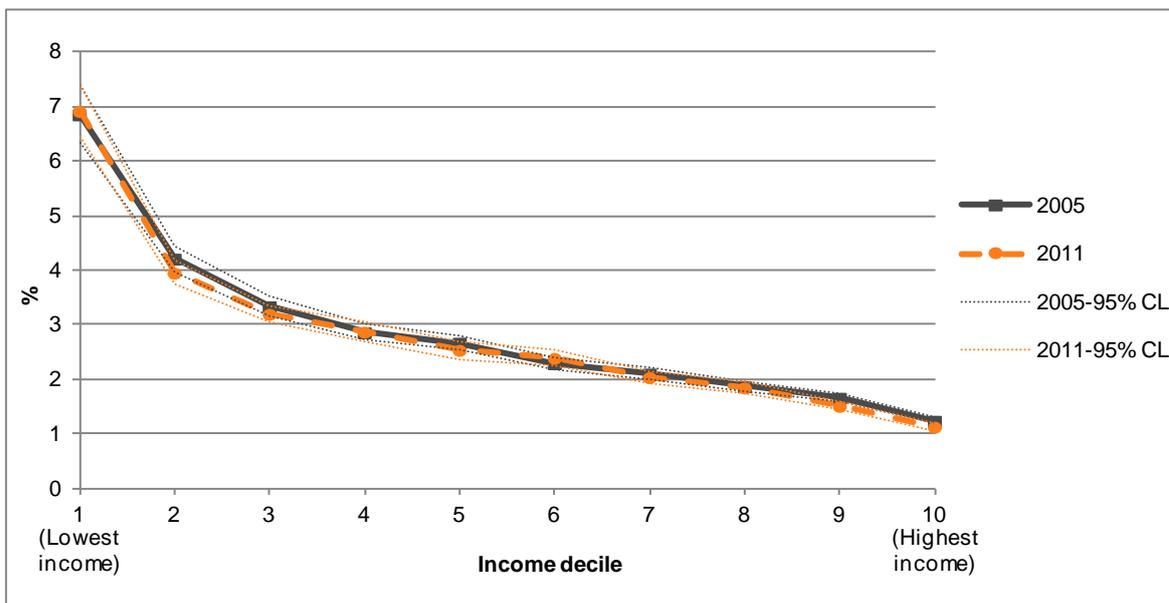
b) Share vs social exclusion by decile
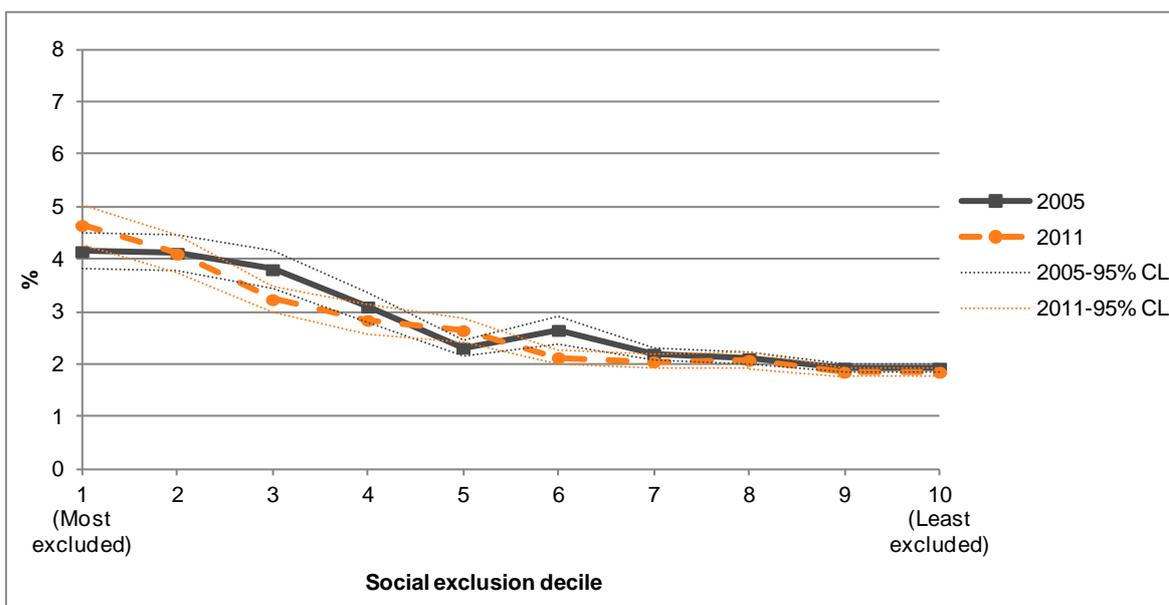
Notes: CL = confidence limits

The share of income accounted for by fuel expenditure is the ratio between expenditure and income where none of these variables is equivalised.

In figure a) households are grouped according to their equivalent incomes computed using the modified OECD equivalence scale.

Source: Authors' calculations using data from the HILDA survey

4 Findings: analysis of fuel poverty

Since the early 1970s various definitions have been proposed in the literature to quantify and characterise *fuel poverty* in high-income countries.[10] Originating in regions with cooler climates, the measures of fuel poverty have focused on the extent to which households can afford adequate warmth in their home. The different concepts aim to capture the inability to afford adequate temperature at home, which is assumed to be a function of the relationship between economic resources available, as measured by household disposable income, and the total amount spent on fuel by the household.

Table 4.1 shows the five definitions of fuel poverty used in our analysis. We considered three definitions of fuel poverty based on income in relation to fuel expenditure. The first formal definition proposed by Boardman (1991) identified as fuel-poor all households whose fuel costs exceeded 10 per cent of their income. This is an absolute definition of fuel poverty, as the threshold used is arbitrary and independent of the actual distribution of the cost-to-income ratio in the population. Alternatively, Moore (2012) proposed a relative definition of fuel poverty where the threshold is set at twice the median cost-to-income ratio. In a review of fuel poverty in the United Kingdom, Hills (2012) proposed a 'low income–high cost' indicator under which households are considered to be in fuel poverty if they have fuel costs that are above the median level, **and** their residual income after fuel expenditure is below the official poverty line.

We considered a second group of fuel poverty indicators consistent with the *consensual* approach to the measurement of fuel poverty. By contrast with the income–expenditure approach, the consensual measures are intended to capture the exclusion dimensions of fuel poverty without taking into account information on income and expenditure. Following Thomson and Snell's (2013) comparative analysis of fuel poverty in the European Union, we consider two proxy indicators: inability to keep the home adequately warm, and inability to pay utility bills on time. These indicators are modelled as 0–1 variables that take the value 1 when the household reports that they cannot keep their home warm and cannot pay the bills on time, respectively.

Table 4.1   Summary of definitions used to identify fuel-poor households in this analysis

Income–expenditure definitions	*Use information only on households' income and fuel expenditure*
Low income–high cost	Identifies households who have fuel costs above the median level **and** a residual income after fuel expenditure below the official poverty line (following Hills 2012)
Cost–income ratio>0.1	Identifies households whose fuel costs exceed 10 per cent of their income (following Boardman 1991). This is an absolute measure
Cost–income ratio > 2 x median ratio	Identifies households whose fuel costs exceed twice the median cost-to-income ratio (following Moore 2012). This is a relative measure
Consensual definitions	*Capture exclusion dimensions of fuel poverty*
Unable to heat the home	Identifies households who state they are unable to heat their home (following Thomson and Snell 2013)
Could not pay bills on time	Identifies households who state they cannot pay their electricity, gas or telephone bills on time

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[10] Moore (2012) provides an excellent discussion on the evolution of the definition of fuel poverty. For an analysis of the concepts of fuel and energy poverty and the relationship between them see Li *et al.* (2014).

Applying five energy poverty definitions to the HILDA sample

Table 4.2 shows the prevalence of fuel poverty in Australia for the period 2005–11. Several of these results deserve comment. First, there are important differences in the number of households identified as fuel-poor by the various definitions. Thus, while the incidence of households that are unable to heat the home or spend more than 10 per cent of their income on energy is 2–3 per cent throughout the period, the percentage of households with a cost–income ratio larger than twice the median ranges between 17 and 20 per cent. In absolute terms, our estimates imply that in 2011 more than 300,000 households in Australia are unable to heat their home whereas more than 1.5 million have a relative high cost–income ratio.[11] Estimates of fuel poverty for the other definitions lie between these two extremes. About 8 per cent of households are identified as fuel-poor according to the low income–high expenditure definition, whereas the number of households that report they could not pay bills on time is between 8 and 11 per cent. The relatively low incidence of households identified as unable to heat the home may reflect the lack of relevance of heating the home to those Australians who live in warmer climates.

Interestingly, our results show little time-variation in the prevalence of fuel poverty: for most definitions the prevalence of fuel poverty at the start and the end of the period are very similar. This is a little surprising given the marked increase in electricity prices; however many—but by no means all—incomes have risen enough to keep pace with energy prices. It could be useful to do an analysis of households relying on Newstart Allowance or Youth Allowance, which are indexed by the CPI rather than Male Total Average Weekly Earnings (MTAWE) by which pensions are indexed.

Table 4.2   Incidence of fuel poverty, Australia 2005–11

Year	Fuel poverty definition (% of households)				
	Low income–high cost	Cost–income ratio > 0.1	Cost–income ratio > 2 x median	Unable to heat the home	Could not pay bills on time
2005	8.64	2.55	17.74	2.15	11.32
2006	8.35	2.62	19.56	1.92	11.05
2007	8.29	2.28	19.69	1.78	10.01
2008	8.14	2.76	19.38	2.00	8.65
2009	7.91	2.72	20.07	2.05	9.50
2010	8.41	3.03	19.80	n.a.	n.a.
2011	8.47	3.24	19.76	3.71	10.93

Note: For a description of the definitions see the main text on page 8. Information about whether households are able to heat the home and pay bills on time is not available for 2010.

Source: Authors' calculations using data from the HILDA survey.

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[11] According to the 2011 Census data there were 8.18 million households in Australia on census night.

Assessing overlap between fuel-poor households identified by different definitions

A natural question when characterising poverty using alternative concepts is whether the alternative definitions identify the same group of vulnerable households or not. We investigate this issue by looking at the degree of overlap between the various fuel poverty indicators. Table 4.3 shows the frequency distribution of households by the number of indicators which identify them as fuel-poor. Our estimates for four different years show that about 28 per cent of the Australian households are identified as fuel-poor by at least one indicator. The majority of those identified as fuel-poor are identified only by one indicator. Thus, we find that about 17 per cent of the households are classified as fuel-poor by only one indicator, around 7 per cent by two indicators, and 3–4 per cent by three or more.

Table 4.3   Distribution of households by the number of indicators identifying them as fuel-poor, selected years

Number of indicators	% of households, by year			
	2005	**2007**	**2009**	**2011**
0	71.45	73.23	72.1	71.17
1	17.44	16.37	17.2	17.09
2	7.82	7.25	7.7	7.31
3 or more	3.29	3.15	3.01	4.43

Source: Authors' calculations using data from the HILDA survey.

Table 4.4 reports estimates of the degree of overlap between the different fuel poverty indicators for all possible binary combinations of these indicators. For each pairwise combination two measures of overlap are presented. First we report the proportion of households that are classified as fuel-poor by both definitions (Table 4.4, top panel). Second, in order to control for differences in the incidence of fuel poverty across the different indicators, we also report a second measure of overlap defined as the share of households classified as fuel-poor by the two indicators expressed as a percentage of the group of households identified as fuel-poor at least by one of the indicators (Table 4.4, bottom panel).[12]

Estimates in the top panel of the table show that the percentage of all households identified as fuel-poor by both indicators is below 3 per cent for most pairwise comparisons. For some measures, we find that the degree of overlap is above that level. Thus, for instance, almost 7.5 per cent of households are classified as low income–high cost and have a cost–income ratio above twice the median. Note, however, that this result is partially explained by the larger prevalence of households with cost–income ratios above twice the median (see Table 4.1).

To obtain a better picture of the extent of overlapping while controlling for differences in the prevalence of the indicators, we must turn our attention to the second measure of overlapping. Results in the bottom panel of Table 4.4 show that the rate of mismatch, defined as the extent to which two definitions identify different people, between the different poverty concepts is remarkably high.

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[12] Note this group includes all those households identified by only one indicator as well as those identified by the two indicators.

Table 4.4   Overlapping between fuel poverty indicators, Australia

Indicator	% of all households identified as fuel-poor by the two indicators			
	Cost–income ratio > 0.1	Cost–income ratio > 2 x median	Unable to heat the home	Could not pay bills on time
Low income–high cost	2.03	7.48	0.42	1.53
Cost–income ratio > 0.1	-	2.74	0.15	0.48
Cost–income ratio > 2 x median	-	-	0.79	3.03
Unable to heat the home	-	-	-	1.48

	% of households identified as fuel-poor by the two indicators among those identified as fuel-poor at least by one of the two indicators			
	Cost–income ratio > 0.1	Cost–income ratio > 2 x median	Unable to heat the home	Could not pay bills on time
Low income–high cost	22.53	36.93	4.03	8.93
Cost–income ratio > 0.1	-	14.12	2.85	3.83
Cost–income ratio > 2 x median	-	-	3.77	11.39
Unable to heat the home	-	-	-	13.34

Note: Overlapping estimates are equal to the average level of overlapping for the period 2005–2011, except for the *consensual* measures for which the average is computed excluding year 2010 because of the lack of available data for that year.

Source: Authors' calculations using data from the HILDA survey.

For example, less than 3 per cent of those identified as fuel-poor either by absolute cost–income ratio indicator (10% threshold) or the unable to heat the home indicator are classified as fuel-poor by both these two indicators. The largest overlap is observed between the low income–high cost indicator and the relative cost–income ratio measure (2 x median threshold) as nearly 37 per cent of those classified as fuel-poor by one of the indicators is also classified as fuel-poor by the other. Interestingly, our results indicate a large level of mismatch between income–expenditure based measures and consensual indicators of fuel poverty. In fact, for most pairwise comparisons involving indicators from these two categories, the degree of overlapping is below 10 per cent.

Socioeconomic profile of those identified as fuel-poor

The large level of mismatch between the fuel poverty concepts suggests differences in the socioeconomic profiles of those identified as fuel-poor. To investigate this issue Table 4.5 shows the distribution by population subgroups of the fuel-poor for the different definitions of fuel poverty. (Note that this table does not show the likelihood (or risk) of different household types being fuel-poor. Instead it shows which household types feature most strongly when fuel-poor households are identified by the five definitions.)

Table 4.5   Socioeconomic characteristics of fuel-poor households in Australia

Characteristic	Fuel poverty definition (% of households)				
	Low income– high cost	Cost–income ratio > 0.1	Cost–income ratio > 2 x median	Unable to heat the home	Could not pay bills on time
Male	65.66	57.23	64.91	52.48	63.59
Female	34.34	42.77	35.09	47.52	36.41
Under 25	3.70	8.63	4.84	7.11	7.02
25–34	9.46	12.01	12.21	13.23	23.35
35–44	15.28	12.02	14.42	18.65	27.28
45–54	16.48	14.33	15.84	27.34	20.10
55–64	15.84	16.86	16.87	18.25	11.20
65 and over	39.24	36.15	35.82	15.41	11.05
Couple, no children	33.92	24.46	30.51	14.68	17.74
Couple with children	20.55	10.82	17.16	15.71	28.98
Lone parent	12.59	7.81	8.97	20.08	18.98
Single	27.69	51.90	38.25	40.48	26.21
Other	5.25	5.01	5.11	9.04	8.09
One household member	27.69	51.90	38.25	40.48	26.21
Two	33.39	28.98	33.40	24.62	25.46
Three	14.58	9.02	12.57	15.25	19.25
Four	11.34	6.53	9.19	11.13	15.78
Five	7.26	2.88	4.65	5.63	8.31
Six or more	5.74	0.68	1.95	2.89	4.99
Major city	57.51	58.41	58.53	58.55	62.42
Inner regional	28.10	26.67	27.74	26.91	25.75
Outer regional	12.92	13.68	12.25	13.50	10.81
Remote Australia	1.47	1.25	1.48	1.04	1.02
Outright owner	46.16	45.86	45.44	16.44	13.20
Owner with mortgage	15.89	13.94	19.42	21.87	29.06
Private renter	20.86	21.84	21.17	37.90	42.67
Public housing tenant	9.72	8.58	6.93	15.40	8.66
Other	7.37	9.78	7.03	8.39	6.41
Household with disability: No	38.55	46.06	45.68	36.11	48.58
Household with disability: Yes	61.45	53.94	54.32	63.89	51.42
Tertiary education	9.89	12.45	13.15	12.21	14.06
Diploma, certificate or Year 12	42.74	43.14	45.45	48.99	49.44
Year 11 or below	47.37	44.41	41.41	38.80	36.50
Employed full-time	17.71	23.77	30.40	28.15	46.31
Employed part-time	11.75	11.52	12.28	14.85	15.07
Unemployed	5.35	6.13	3.74	7.19	5.75
Out of the labour force	65.20	58.58	53.58	49.82	32.88
Jobless household: No	71.38	70.90	78.42	63.59	77.85
Jobless household: Yes	28.62	29.10	21.58	36.41	22.15

Note: Table 4.5 does not show the likelihood (or risk) of different household types being fuel-poor. Instead it shows which household types feature most strongly when fuel-poor households are identified by the different definitions.

Table 4.5 (cont.)

	Fuel poverty definition (% of households)				
	Low income– high cost	Cost– income ratio > 0.1	Cost– income ratio > 2 x median	Unable to heat the home	Could not pay bills on time
Social exclusion level					
20% most excluded	63.30	56.28	42.86	58.58	38.74
Next 20%	27.61	26.84	25.66	19.35	20.95
Next 20%	7.53	10.57	14.24	10.79	17.59
Next 20%	1.21	3.59	9.28	6.89	12.83
20% least excluded	0.35	2.72	7.97	4.39	9.90
Income level					
Bottom 20%	84.66	82.32	52.89	44.34	30.34
Next 20%	15.33	10.05	24.31	24.49	27.41
Next 20%	0.02	4.65	13.23	16.10	22.11
Next 20%	0.00	2.29	7.14	10.98	13.51
Top 20%	0.00	0.69	2.43	4.08	6.63
Fuel expenditure level (not equivalised)					
Bottom 20%	0.00	5.68	3.03	29.31	22.15
Next 20%	1.79	7.75	14.77	22.10	19.43
Next 20%	31.12	12.14	20.30	21.10	20.20
Next 20%	34.59	21.49	21.64	16.74	18.14
Top 20%	32.50	52.95	40.26	10.75	20.07
Fuel expenditure level (equivalised)					
Bottom 20%	0.00	3.58	1.65	28.50	21.82
Next 20%	0.00	7.54	10.92	20.60	17.86
Next 20%	24.34	8.44	18.51	18.69	19.40
Next 20%	38.14	15.96	22.53	17.53	18.71
Top 20%	37.51	64.48	46.38	14.68	22.21
Level of share of income spent on energy					
Lowest 20%	0.00	0.00	0.00	15.82	15.42
Next 20%	0.16	0.00	0.00	12.29	13.62
Next 20%	0.99	0.00	0.00	15.71	18.40
Next 20%	8.31	0.00	0.05	20.75	22.27
Top 20%	90.54	100.00	99.95	35.43	30.29

Note: Attributes of the household correspond to those of the household head. Income and expenditure values equivalised using the modified OECD equivalence scale. Equivalent values of fuel expenditure computed using the factors proposed in Hills (2012). Estimates reported here are the average values of the estimates derived from each wave of HILDA 2005–2011.

Source: Authors' calculations using data from the HILDA survey.

We find that male-headed households are a majority of those in fuel poverty regardless of the definition, though the gap varies. Interestingly, our results suggest significant differences in age distribution of the fuel-poor between the income–expenditure and the consensual measures (Figure 4.1). In particular, those identified as fuel-poor by the low income–high expenditure and the cost–ratio measures tend to be older than those classified as fuel-poor by the consensual measures. In fact, more than one-third of the households identified as fuel-poor by the income–expenditure measures have a head who is aged 65 or above. For the consensual measures, instead, those between 35 and 54 years of age are the largest group among the fuel-poor with more than 45 per cent of poor households headed by someone in that age band.

**Figure 4.2   Age of household head by fuel poverty distribution**
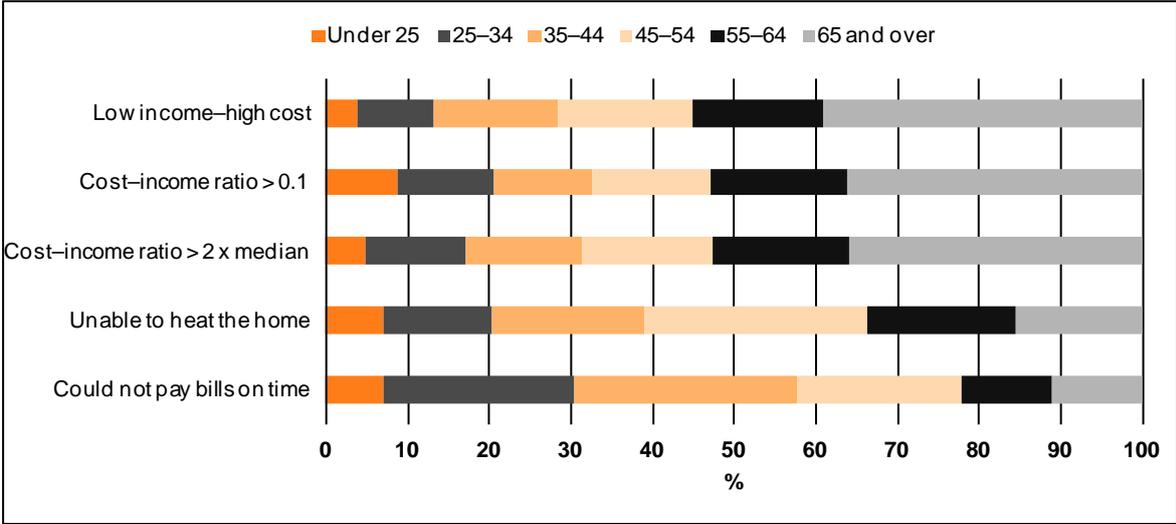
In terms of household structure, couples with no children account for more than one-quarter of the fuel-poor when these are identified using income–expenditure definitions (Figure 4.2). Single-person households have large representation among the fuel-poor, especially for the relative cost–income ratio (52 per cent) and the unable to heat the home (40 per cent) indicators. The majority of fuel-poor households are of small size. Indeed, the share of households with one or two members is always above 50 per cent regardless of the definition considered. However, more than one-third of households that could not pay their bills on time have three or four members, which reflects the larger presence of couples with children in this group relative to other poverty indicators.

Figure 4.3   **Household type by fuel poverty definition**
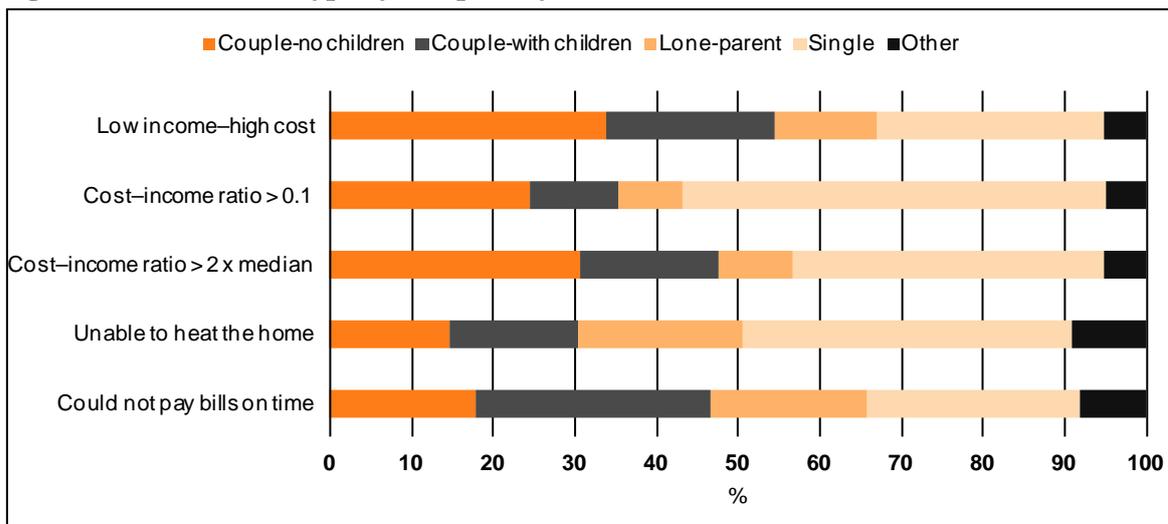
We find notable differences regarding home ownership between the income–expenditure and the consensual definitions of fuel poverty (Figure 4.3). More than 45 per cent of those identified as fuel-poor by the first of group of measures are outright owners and an extra 15–19 per cent are owners with a mortgage. By contrast, private renters are the single largest group among those who are unable to heat the home (38 per cent) or cannot pay bills on time (43 per cent). Households with a member with a disability are clearly overrepresented among those experiencing fuel poverty: disabled households account for more than half of the fuel-poor regardless of the definition, and this percentage goes up to more than 60 per cent in the case of the low income–high expenditure and the unable to heat the home indicators.

Figure 4.4   **Housing tenure by fuel poverty definition**
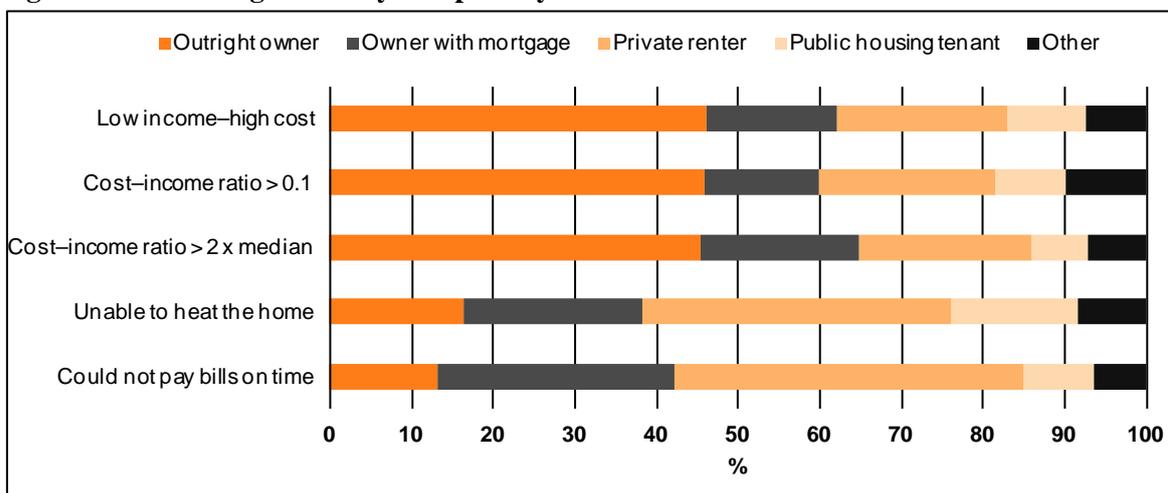
In terms of employment, it is striking that 46 per cent of the households reporting inability to pay their bills on time are headed by someone who is employed full-time; by contrast households with a head out of the labour force are the largest group by all the other fuel poverty definitions.

Socioeconomic disadvantage and various definitions of fuel poverty

On the other hand, our results suggest a clear association between socioeconomic disadvantage and the experience of fuel poverty regardless, of whether disadvantage is measured using an income

poverty definition or the multidimensional indicator of social exclusion. In fact, we find that for most of the fuel poverty definitions more than half of the fuel-poor are among the 20 per cent most excluded. Similarly, the fuel-poor are highly concentrated at the bottom of the income distribution, especially in the case of income–expenditure definitions. Thus, more than 80 per cent of those classified as fuel-poor by the low income-high expenditure and the absolute cost–income ratio definitions fall in the bottom quintile of the income distribution. Those identified as fuel-poor by the consensual measures tend to be better off in terms of income, as suggested by the larger presence of households in the middle and the top income quintiles among these groups of fuel-poor. Similarly, households that cannot pay bills on time are less excluded than other groups. In fact, less than 40 per cent of this group are in the group of most excluded whereas nearly 10 per cent are part of the least excluded group. Interestingly, income–expenditure definitions of fuel poverty identify groups with larger fuel expenditure (whether equivalised or not) than the consensual measures. Indeed, more than two-thirds of those classified as fuel-poor by the low income–high expenditure and the cost–income ratio measures have expenditure levels that fall in the top two quintiles of the expenditure distribution. Households that cannot pay bills on time or heat their homes are more evenly distributed among the expenditure quintiles.

5 Wellbeing comparisons of fuel-poor definitions

The definition of fuel poverty is important for policy formulation not only because it determines the scale of problem identified, but also because it may be used to decide the target population for policy purposes. Therefore it is important to investigate the extent to which alternative definitions of fuel poverty are able to identify those who are most in need. This question becomes especially relevant when the overlap between poverty definitions is very low, as it is in the case of income–expenditure and *consensual* definitions of fuel poverty.

The main objective of this section is to analyse how well the different fuel-poor groups fare in terms of various measures of wellbeing. Table 5.1 shows the median values of various wellbeing indicators by household size for the different groups of fuel-poor households. In particular, estimates for income, the multidimensional indicator of social exclusion and household consumption are reported. Interestingly, we find significant differences between the fuel-poor groups in terms of these wellbeing indicators. Thus, those classified as fuel-poor by the income–expenditure measures tend to have lower median incomes than those identified by the consensual definitions, irrespective of the household size. For households with three members, for instance, the median income among the consensual fuel-poor is above $45,000 by both definitions, whereas the median for those classified as fuel-poor by the income–expenditure definitions lies between $27,000 and $37,000. Compared with those fitting the other income–expenditure definitions, households with a cost-to-income ratio above twice the median have larger incomes and are less excluded, as suggested by their higher median social exclusion scores. In fact, this fuel-poor group and the group of households that cannot pay the bills are the least excluded of all groups, with median values of the social exclusion indicator above 6 for all household sizes.

In terms of annual expenditure, among single-person households, those who could not pay their bills on time have larger median total expenditures (but not fuel expenditures) than the other groups. For households of larger size, we find that those who cannot pay bills and those with a cost–income ratio above twice the median tend to have larger total expenditure than other fuel-poor groups, except in the case of households with three members where those with cost–income ratio above 10 per cent spend more than the rest. Results for total expenditure, however, mask important differences in the type of expenditure. Indeed, regardless of the household size, our results suggest that those identified as fuel-poor by the income–expenditure definitions spend more on fuel than households that are unable to heat their home or cannot pay bills on time. In the case of single households, for instance, while the median expenditure of these two 'consensual' groups of fuel-poor households is below $600, the median expenditure for those identified by the income–expenditure definitions ranges between $900 and $1,400. In contrast, those classified as fuel-poor according to the income–expenditure definitions spend less on other consumption items than the consensual fuel-poor. This is particularly true for the low income–high cost and the absolute cost–income ratio definitions, as the median expenditure on items other than fuel for these two groups is well below that of the other fuel-poor groups, especially in the case of households with one or two people.

Table 5.1   Wellbeing indicators of fuel-poor households in Australia

Household	Fuel poverty definition				
	Low income–high cost	Cost–income ratio > 0.1	Cost–income ratio > 2 x median	Unable to heat the home	Could not pay bills on time
Median annual income (2001 dollars)					
Household size					
1	11,916.14	10,188.00	14,308.80	16,699.10	21,081.52
2	21,018.40	17,556.57	25,731.91	28,917.41	35,055.21
3	27,614.58	20,813.10	36,242.64	47,335.30	45,513.30
4	32,139.78	30,942.07	48,049.11	40,669.90	54,746.61
5 or more	42,005.27	51,269.10	54,420.59	53,929.21	61,003.45
Median social exclusion					
Household size					
1	5.65	5.77	6.00	5.57	6.15
2	5.60	5.66	6.01	5.52	6.18
3	5.55	5.92	6.15	6.12	6.26
4	5.69	5.63	6.40	5.82	6.33
5 or more	5.68	5.52	6.29	5.96	6.22
Median annual expenditure (2001 dollars)					
Household size					
1	9,661.22	10,704.73	12,420.21	15,129.49	18,683.70
2	16,056.26	17,806.08	19,871.12	18,447.07	23,433.83
3	21,222.55	34,041.15	27,451.24	25,621.62	28,764.00
4	26,556.31	27,833.70	36,393.50	27,065.58	35,231.25
5 or more	32,673.25	31,722.88	39,945.49	31,439.52	37,792.70
Median annual fuel expenditure (2001 dollars)					
Household size					
1	1,024.86	1,398.60	932.40	539.40	594.30
2	1,222.47	2,237.20	1,427.30	752.00	819.68
3	1,438.40	2,357.42	1,880.00	975.60	1,018.80
4	1,554.00	3,231.96	2,397.00	823.53	1,203.20
5 or more	1,554.00	5,968.37	2,517.20	1,052.80	1,240.80
Median annual non-fuel expenditure (2001 dollars)					
Household size					
1	8,484.06	9,306.13	11,490.42	14,741.46	18,006.64
2	14,754.77	15,178.71	18,506.44	17,933.70	22,619.69
3	19,955.90	25,451.34	25,451.34	24,265.61	27,605.00
4	24,224.18	21,781.08	34,078.01	26,669.64	33,370.00
5 or more	31,458.06	25,779.88	37,468.30	30,738.48	36,445.68

Note: Estimates derived using pooled data from waves 5–11 of the HILDA survey. All income and consumption are not equivalised.

Source: Authors' calculations using data from the HILDA survey.

Dominance analysis: income poverty, social exclusion and household expenditure

Although informative about the relative performance of the different fuel-poor groups, the comparison of median values does not provide information about the *levels* of disadvantage experienced by those groups. Poverty comparisons across groups for a given welfare indicator may depend on various methodological choices that one must take when measuring poverty. These include the indicator used to quantify poverty and the poverty threshold chosen, as well as the equivalence scale selected. It is therefore important to find methods that allow the analyst to check the robustness of poverty comparisons to these choices. For the present analysis we use the sequential stochastic dominance conditions for poverty comparisons between household groups proposed in Duclos and Makdissi (2005) (see Box 5.1).

Box 5.2   Robust poverty comparisons

The Duclos and Makdissi's (2005) methodology can be described as follows. Let x be the variable containing all the information that is relevant to determine the poverty of any given household. This could be any of the standard variables used in the poverty literature such as income or expenditure. We denote by $d_k(x)$ the poverty function that informs us about the level of deprivation experienced by a household of size k with value x. For the present analysis we consider five different sizes of households from one to five (or more) members. The poverty function is assumed to be a non-negative function that takes value 0 for all households with x above a particular threshold z_k. Furthermore we assume that the total poverty for a given population can be expressed as the sum of the poverty experienced by the households in that population.

Following the poverty literature, we consider different classes of poverty indices denoted by Π^S, where $s=1,2,3,\ldots$ represents the order of stochastic dominance. For $s=1$ the class Π^S includes all deprivation functions for which an increase in x leads to a reduction in poverty whatever the size of the household and the associated reduction of poverty is larger for households of larger size. The class Π^2 includes all those indices consistent with the Pigou-Dalton principle, according to which a rank-preserving progressive transfer from a deprived household to a more deprived household reduces the overall level of deprivation and this effect is larger when the transfer involves households with more members. For s=3, the assumption implies that deprivation indices satisfy the composite transfer principle, which stipulates that a progressive transfer between deprived households in conjunction with a regressive transfer between rich households is poverty-reducing if the variance of the distribution does not increase as a consequence of those transfers, and also the magnitude of this effect increases with the size of the households involved.

For a population A, let $F_{Ak}(x)$ be the distribution function of x among the households of size k in that population defined over the interval $[0,a]$. For each order of stochastic dominance the function $D^s_{Ak}(x)$ is defined as follows: $D^1_{Ak}(x) = F_{Ak}(x)$ for s=1 and $D^s_{Ak}(x) = \int_0^x D^{s-1}_{Ak}(x)dx$ for s=2,3. Let θ_{Ak} denote the relative frequency of households of size k among population A. The Proposition 1 in Duclos and Makdissi (2005) allows us to derive unambiguous poverty rankings for any class of poverty measures Π^S. Thus, given two populations A and B, one can conclude that poverty in group A is lower than in B for all poverty measures in class Π^S if and only if the following condition is satisfied:

$$C^s_{Ak}(x) \leq C^s_{Bk}(x) \ \forall \ x \leq z_k^+ \ and \ k = 1,\ldots,5 \qquad [1]$$

where $C^s_{Ak}(x) = \sum_{l=k}^{5} \theta_{Al} D^s_{Al}(x)$ and $C^s_{Bk}(x)$ is defined analogously, and z_k^+ is the maximum admissible poverty threshold for households of size k. To conclude that population A has unambiguously less poverty than B for a class Π^S, it is necessary to check that condition [1] holds for all household sizes. For the comparisons of the different groups of fuel-poor we first check the existence of dominance of order one. In the absence of dominance we subsequently increase the order of dominance until a robust poverty (income, social exclusion, expenditure) ordering is found. For the empirical analysis the maximum order of dominance we considered was three.

We apply this approach[13] using in turn household income, social exclusion and household expenditure (consumption) indicators. In this way we will be able to derive poverty (and social exclusion and expenditure) rankings of the different groups of fuel-poor and identify those cases where it can be said that one group is poorer than other regardless of the indicator, the poverty line, and the equivalence scale considered (see Box 5.1).

Table 5.2 shows the results from our poverty dominance analysis for the income, social exclusion, and expenditure welfare indicators. We perform all possible pairwise poverty comparisons of the different groups and for each comparison we report whether one group is unambiguously dominated (i.e., has more poverty or social exclusion) by the other group as well as the order of the dominance. When no dominance is found at any level a dash (–) is reported.

Poverty comparisons based on household income show that fuel-poor groups identified by the income–expenditure concepts are poorer than other groups. In particular, we find that the low income–high expenditure and the absolute cost–income ratio definitions are first-order dominated by all other definitions which implies that these two groups of fuel-poor households can be said to be poorer in terms of income according to a broad set of poverty indicators and poverty lines.

Most of these dominance results disappear when poverty comparisons are based on the social exclusion indicator instead of the income indicator. We find that those identified as fuel-poor by the consensual definitions of fuel poverty, especially those who are unable to heat their homes, are unambiguously more excluded than other groups. However, none of these dominance results involve the low income–high expenditure and the absolute cost–income ratio poor groups, which implies that no robust social exclusion comparison can be made between these two groups and the consensual fuel-poor.

Interestingly, results derived using consumption (expenditure) as the welfare indicator suggest that those who are unable to heat the home tend to be worse off than those identified as fuel-poor by the income–expenditure measures. Thus, the unable to heat the home group is poverty dominated by those classified as poor by the low income–high expenditure and the absolute and relative cost–income ratio definitions, although in the latter case dominance is only found for s=2.

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[13] For an application of these methods see Makdissi and Wodon (2006).

Table 5.2   Poverty dominance results

Household income					
	Low income–high cost (I_0)	Cost–income ratio > 0.1 (I_1)	Cost–income ratio > 2 x median (I_2)	Unable to heat the home (I_3)	Could not pay bills on time (I_4)
Low income–high cost (I0)		-	(I_2 D I_0; s=1)	(I_3 D I_0; s=1)	(I_4 D I_0; s=1)
Cost–income ratio > 0.1 (I1)			(I_2 D I_1; s=1)	(I_3 D I_1; s=1)	(I_4 D I_1; s=1)
Cost–income ratio > 2 x median (I2)				-	-
Unable to heat the home (I3)					-

Social exclusion					
	Low income–high cost (I_0)	Cost–income ratio > 0.1 (I_1)	Cost–income ratio > 2 x median (I_2)	Unable to heat the home (I_3)	Could not pay bills on time (I_4)
Low income–high cost (I_0)		-	(I_2 D I_0; s=2)	-	-
Cost–income ratio > 0.1 (I_1)			-	(I_1 D I_3; s=1)	-
Cost–income ratio > 2 x median (I_2)				-	(I_2 D I_4; s=2)
Unable to heat the home (I_3)					(I_4 D I_3; s=2)

Household expenditure					
	Low income–high cost (I_0)	Cost–income ratio > 0.1 (I_1)	Cost–income ratio > 2 x median (I_2)	Unable to heat the home (I_3)	Could not pay bills on time (I_4)
Low income–high cost (I_0)		-	-	(I_0 D I_3; s=1)	-
Cost–income ratio > 0.1 (I_1)			-	(I_1 D I_3; s=1)	-
Cost–income ratio > 2 x median (I_2)				(I_2 D I_3; s=2)	-
Unable to heat the home (I_3)					-

Note: Estimates derived using pooled data from waves 5–11 of the HILDA survey. All income and consumption are not equivalised. For any two fuel-poor groups *i* and *j*, (I_i D I_j; s=k) means that group *i* is poorer than group *j* for class of poverty measures Π^k for any equivalence scale.

Source: Authors' calculations using data from the HILDA survey.

Results from our analysis illustrate the difficulty of finding a concept of fuel poverty that captures all aspects of fuel poverty and the negative consequences of these on families' wellbeing. The low levels of overlap between fuel poverty indicators as well as the differences in the profiles of the fuel-poor groups reported here indicate that the different definitions proposed in the literature treat the different aspects of fuel poverty differently. Furthermore, welfare comparisons of the fuel-poor groups in general depend on the welfare measure used to perform those comparisons, highlighting the challenge of designing policies for addressing fuel poverty that target those who are most in need. Our analysis suggest that policy makers will need to make a decision about the groups that are most at risk as there is no single definition of fuel poverty that identifies those groups.

Appendix A: The BSL–UoM social exclusion measure

The multidimensional measure of social exclusion proposed in Scutella et al. (2009a,2009b) combines information on 30 indicators from seven different domains: material resources; employment; education and skills; health and disability; social; community; and personal safety. Table A.1 lists the indicators included in each domain. For any individual i the measure of social exclusion, x_i is defined as 10 minus the weighted sum of the level of social exclusion experienced within each domain, $x_{i,d}$, where every domain is assigned equal weight. The level of exclusion in any domain is given by the actual proportion of indicators within the domain in which the individual is deprived.

Table A.1 The BSL-UoM measure of social exclusion*

Domain	Indicators
Material resources	Low income
	Low net worth
	Low consumption
	Financial hardship
	Financial status
Employment	Jobless household
	Long-term unemployment
	Unemployment
	Underemployment
	Marginal attachment to workforce
Education and skills	Low education
	Low literacy
	Low numeracy
	Poor English
	Little work experience
Health and disability	Poor general health
	Poor physical health
	Poor mental health
	Long-term health condition or disability
	Household has disabled child
Social connection	Little social support
	Infrequent social activity
Community	Low neighbourhood quality
	Disconnection from community
	Low satisfaction with the neighbourhood
	Low membership of clubs and associations
	Low volunteer activity
Personal safety	Victim of violence
	Victim of property crime
	Feeling of being unsafe

Appendix B: Main forms of energy assistance

- **Energy bill concessions** are provided as discounts on eligible householders' energy bills. In most states eligibility is means-tested and based on holding a pensioner concession card, health care card, or DVA gold card. These concessions are funded by state and territory governments. An additional discount on utility bills is provided to pensioners, people with a disability and carers by the Commonwealth Government.

- **Emergency circumstances grants** are provided as a one-off payment to assist in meeting an electricity bill. They are funded by state governments and differ between states in the amount, eligibility and process for application. Most emergency grants have limitations on the number of applications in a given time period.

- **Special circumstance concessions** vary between states, but may include a concession for households who need to run a life support system run a dialysis machine, or have a medical condition requiring higher levels of cooling.

- **Energy billing hardship programs** are implemented and funded by energy retailers and assist households who are unable to pay their energy bills. The frameworks for these programs are mandated by state or national regulations.

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