Energy Spending and Vulnerable Households

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Abstract

A sustainable energy policy needs to balance between the reduction of carbon emissions and protection of vulnerable households and avoid a widening of the existing "energy gap" among the consumers. This study investigates energy spending for different consumer groups, in particular focussing on vulnerable households. Vulnerable households are more likely to be affected by fuel poverty and have difficulties in warming their homes adequately. In this context we explore energy spending among households on very low incomes, including pensioners, female single parent, and benefit recipients. We describe how energy spending of these households has changed over time using a household panel dataset covering a period of 17 years, starting in 1991. We discuss the reasons that these households have higher than average energy bills and the current policy context and approaches such as the implementation of smart metres are addressed.

Keywords Fuel poverty, energy equity, energy spending

JEL Classification D1, Q41

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1. Introduction

As with most goods and services there are significant variations in the energy use and spending levels among different households. Most of these differences can be explained by specific household characteristics such as income, the number of family members, the type and size of a family's home, or geography. As a consequence, the effect of changes in energy prices, incomes, or energy policy measures can vary across different types of families. In recent years, fuel poverty among vulnerable households and energy equity has occupied an important place in the energy policy debate.

In this paper we focus on the UK. In Britain, according to the official definition, households that spend more than 10% of their incomes on energy are described as "fuel poor" and having difficulties in warming their homes adequately. The fuel poverty ratio is calculated as fuel costs (usage multiplied with price) divided by income. If this ratio is larger than 0.1, a household is considered as being fuel poor (DECC, 2009c).

Vulnerable households are at especially high-risk in terms of being affected by fuel poverty (Defra and BERR, 2008). A household is considered as vulnerable if some of its members are children, elderly, sick or disabled. The number of families that spend a large share of their income on energy has increased again

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since 2004 (DECC, 2009b). Three factors play a major role in fuel poverty: income, energy prices and energy efficiency. Currently about 4 million households in the UK are considered fuel poor and more than 80% of these are vulnerable households (DECC, 2009c).

At the same time, there is concern that efforts towards achieving renewable energy and climate change policies can result in higher energy prices and higher fuel poverty. It is therefore important to design policies to help the most affected groups. However, wrong types of policies can also lead to inefficient use of energy. In this paper, we explore energy spending among households on very low incomes, including pensioners, female single parent households, and benefit recipients. We describe how energy spending of these households has changed over time in order to shed light on energy spending more broadly.

2. Background and Past Studies

Household energy spending and consumption has been in the focus of research since the 1970s. As the energy efficiency in the industrial sector has gradually improved, the potential of reducing energy usage in the domestic sector has become more important. The availability of micro data has enabled researchers to analyze and compare the energy usage and behaviour of households. The literature can be divided into two main groups according to the modelling approach. First, discrete-continuous models describe a two step decision of households. Households first choose the energy consuming appliances they need and then decide the extent to which they actually use their appliances. Studies in this area are available for the UK (Baker and Blundell, 1991) and several other countries (Dubin and McFadden, 1984; Nesbakken, 1999 and 2001; Vaage, 2000; Liao and Chang, 2002).

Second, conditional demand models focus on the usage of energy consuming appliances. Energy demand is modelled as being conditional on the existing appliance stock. The conditional energy demand or spending approach has been explored for Great Britain (Baker et al., 1989; Meier and Rehdanz, 2009), Denmark (Leth-Petersen and Togeby, 2001), Germany (Rehdanz, 2007) and for developing countries (Wu et al, 2004). Baker et al. (1989) present an extension of this approach. The study uses a two-stage budgeting model where, independent from their stock of appliances, households first allocate their income between energy and all other goods and then distribute the share of their income on energy spending among the different fuels.

Independent from the modelling approach, most of these studies analyse income and price responses of households. Income elasticities of energy demand show how energy demand changes with income and could indicate the possible effects of income supporting policy measures on energy spending. The estimated income elasticities are mainly positive but are not larger than 1 suggesting that energy demand increases with income but this increase is less than proportionate. Some studies estimate price responses for different fuels. Their main findings indicate that own price elasticities are negative but are well below 1 (in absolute value). Price increases thus do not lead to strong demand reductions. Moreover, the demand for one type of fuel is found to be affected by

the price of other fuels. The strength of the response is given by cross price elasticities which are mainly positive - i.e. the demand for one type of fuel increases when the price of another fuel increases (Dubin and McFadden, 1984; Baker et al., 1989; Baker and Blundell, 1991; Nesbakken, 1999; Vaage, 2000; Rehdanz, 2007; Meier and Rehdanz, 2009).

More differentiated results can be found in studies that analyse specific groups of households separately. Different household income groups react differently to changes in income and energy prices. Using a British panel data Jamasb and Meier (2010) find that households on low incomes have lower income elasticity of energy spending than those with higher incomes. Baker et al. (1989) estimate income elasticities for heads of households older than 65 and show that these households react weakly to income changes. Households with at least one child younger than the age of five years in comparison have very high income elasticities (Baker et al., 1989). Price responses also differ across household groups. Nesbakken (1999) finds that high income households in Norway react more sensitively to energy price changes. Jamasb and Meier (2010) estimate a similar link for gas prices and gas spending and find low income households to be more responsive to electricity price changes than those with high incomes.

Belonging to a specific socio-economic group can also lead to a higher probability of being affected by fuel poverty (Bennett et al., 2002). In particular, low incomes lead to fuel poverty even though not all low income households are fuel poor (Palmer et al., 2008) or consider themselves as being fuel poor (Waddams et al., 2007). Next to income, other socio-economic characteristics such as household size, age, number of children, employment status or tenancy are drivers of the energy spending level of households (see, for example, Meier and Rehdanz, 2010).

In addition to income levels, some studies have shown that age has a significant influence on energy spending. Elderly households tend to be more energy intensive than other groups of households. They generally consist of a smaller number of occupants but live in more spacious dwellings. Hence they tend to demand more space heating than other households (Liao and Chang, 2002). Elderly people as vulnerable households face two problems: they often live on very low incomes and their larger than average dwellings are often poorly insulated. Thus, they have high energy consumption and bills in order to sustain a certain level of warmth and as a result cause higher than average carbon emissions (Roberts, 2008).

Policy measures to reduce carbon emissions might thus affect fuel poor households to stronger extents. Dresner and Ekins (2006), for example, analyse the effect of carbon taxation on fuel poor households. These households may have to pay relatively higher taxes if they live in poorly insulated homes and already face high energy bills. Compensating these households with a simple benefit system is rather difficult. In addition there is a difference between the objective measure of fuel poverty and the perception of households facing difficulties in warming their homes adequately. Waddams Price et al. (2007) show that while some households feel fuel poor they are not a policy target group, thus the current policy measures will not improve their condition.

Next to low income and elderly households, space heating expenditures of welfare recipients in Germany is analysed in Rehdanz and Stöwhase (2008). The study shows that welfare recipients have significantly higher heating expenditures than other households as their spending is fully covered by benefit payments. Hence the incentives to reduce heating consumption among this group of households is low leaving some scope for devising suitable policy measures to reduce overall domestic energy consumption.

Altogether, we can conclude from the evidence provided by the existing literature that households are likely to differ in their energy usage according to some specific socio-economic characteristics. In the rest of this chapter we further explore energy spending of vulnerable groups of households and give some insights into how these households differ from the average population and analyse some household characteristics that seem to lead to the observed differences in energy spending.

3. Types of Vulnerable Households

Officially, low income households are defined as households with an income below 60% of median disposable income (ONS, 2009). These households are regarded as a high risk group of spending a great share of their incomes on fuel. It is noteworthy that low income households often fall into more than one category of vulnerable households. For example, single persons aged 60 years and older belong to a large extent to the low income group (DECC, 2009b). The UK government has implemented a range of measures to improve the income situation and to tackle poverty. These include income support and energy efficiency measures aimed at tackling pensioner poverty and child poverty (DECC, 2009b).

Elderly people run particular risk of being affected by fuel poverty. Tackling fuel poverty of the elderly is expected to become a growing concern as the group of elderly people becomes larger in the UK. For example, between 1983 and 2008, the population aged 65 and older increased by 1.5 million. In the same period, the number of people aged 85 and over increased at even a faster rate (ONS, 2009). This demographic change has several implications. In 2007 almost 25% of fuel poor households had at least one occupant 75 years age or older (DECC, 2009a). In response, policy makers have developed measures that especially address the elderly groups. In England, for example, householders qualify for the Warm Front Scheme if they are aged 60 or over and receive one or several of specified benefits, for example Pension Credit which tops up the weekly income to a guaranteed minimum level. Warm Front Grants cover insulation and heating measures with a maximum value of £3,500 (or up to £6,000 if fuels other than gas are used, DECC, 2009c). Pensioners should automatically receive Winter Fuel Payments if they are 60 and over. These payments are even higher if a householder is at least 80 years old (DECC, 2009c).

Another group of households that we are interested in are the benefit recipients. In the context of this paper benefit recipients are defined as households that receive Jobseeker's Allowance or Income Support. In Britain, income support is an extra payment to people who satisfy all of the following criteria: being on low

incomes if they are between 16 and 59 years old while not full time employed or full time students; not receiving Jobseeker's Allowance; and not having savings above £16,000. Recipients of Income Support are for example, sick or disabled or lone parents responsible for a child up to 12 years old. A part of income support also covers certain housing payments. Jobseeker's Allowance is another working age benefit and is paid to those available for work and actively seeking. Individuals working less than 16 hours per week are also eligible for this benefit (Jobcentre Plus, 2010). Benefit recipients tend to live on low incomes and in addition they are likely to spend more time at home than full time employees. Both of these factors could contribute to higher than average energy spending over income shares.

We also examine the case of female single parent households in our analysis as these have a high probability of being affected by fuel poverty as some members of these households are children. Most of the lone parents do not work full time and thus these live to a large extent on lower incomes. Moreover, lone parents tend to be mainly single mothers. Consequently in our analysis we specifically concentrate on this group of female single parent households.

4. Data

We base our study of household energy expenditures and analysis of their characteristics on the British Household Panel Survey (BHPS). The BHPS data consists of an unbalanced[2] panel of about 5,500 households that have been re-interviewed over a period of 17 years, running from 1991 to 2008. The main purpose of the survey is to understand the dynamics of change in the British population. In order to collect a representative sample for Great Britain, household addresses have been clustered and stratified. The main selection criteria for the sample are age, employment and retirement.

While the dataset covers several social and economic domains it is not certain that it is statistically fully representative of the British population concerning, for example, the distribution of income levels. We use the Consumer Price Index, CPI of the UK Office for National Statistics (ONS) with 2005=100 (ONS, 2009) in order to adjust all monetary values relative to price developments in the wider economy.

The developments of household energy spending over time are influenced by movements of gas and electricity prices. Figure 1 shows the average yearly gas and electricity price developments for the UK during the period of our study. The data is drawn from the IEA (1997) and IEA (2008).[3] Both prices have developed rather similarly, and were below their 1991 levels until 2005 and reached comparably low levels in 2003.

The restructuring of the electricity market started in 1989 with the British Electricity Act that went into force in March 1990. Consumers seem to have profited from efficiency gains after 1995 as reflected in the rather strong

[2] An unbalanced panel is a panel that does not have the same number of observations in every period (balanced panel), i.e. the number of interviewed households varies over time.
[3] The IEA data is also published by the Department of Energy and Climate Change (DECC).

reduction in electricity price from 1995 (Newbery and Pollitt, 1997). Also, in 1993 the Value Added Tax (VAT) on domestic fuels was introduced at a rate of 8% (Fouquet, 1995) but this was then reduced again to 5% in 1997 (Boardman, 2010). Since 2005 electricity and gas prices have both significantly increased in real terms impacting the link between energy spending and income. Figure 1 also shows that electricity prices largely follow the price of gas reflecting the rapid increase in the share of combined cycle gas turbines (CCGT) as the preferred generation technology by new entrants in the post liberalisation period in the UK (Green and Newbery, 1992; Green and Newbery, 1993).

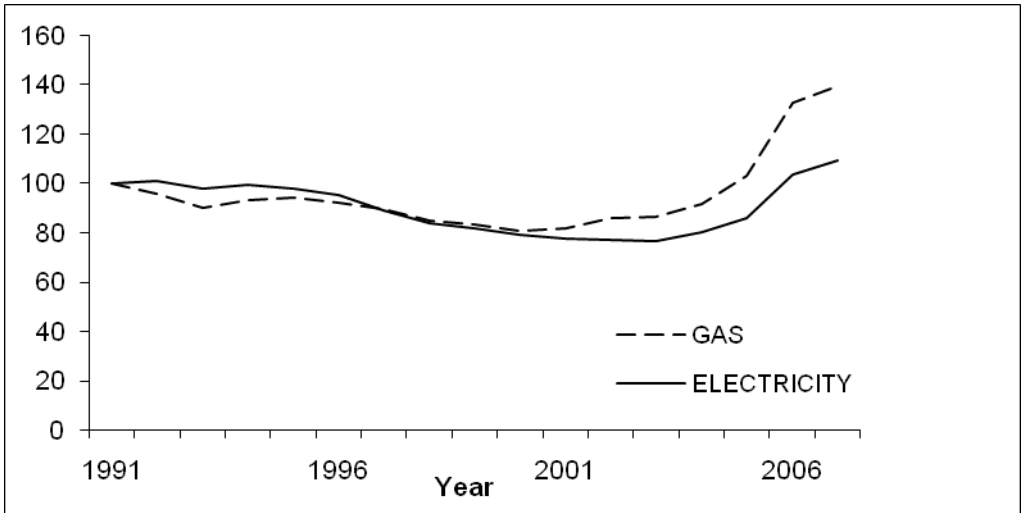

Fig.1: Real Gas and Electricity Price Index, 1991=100

Source: IEA 1997 and 2008, ONS, 2005.

Although privatisation and competition initially led to an overall decrease in energy prices, an analysis of distributional impacts on consumers has shown that some consumers did not gain from these. Thus privatisation and competition have not been a better solution for all consumers. Paying more attention to distributional and social impacts would have led to better policy design and should be taken into account in the future. An analysis of the different tariffs that came into effect after the liberalisation of the energy markets indicates that a mix of fuel poverty and specific household characteristics might lead to some households being worse off than before. In particular large households with low incomes seem to have been adversely affected by the new tariff structures since they have comparably large energy expenditure (Bennet et al., 2002).

5. Vulnerable Households and Energy Spending

The number of (vulnerable) fuel poor households decreased up until 2003/4 and then increased again in recent years. Figure 2 presents the development of fuel poor households subdivided into different vulnerable groups based on the BHPS data. It can be seen that the different household groups altogether make up almost all of the fuel poor households. Also, the development over time represents the trend as described by the Fuel Poverty Advisory Group, 2009

which is based on the English House Condition Survey, EHCS, and similar datasets for Scotland, Wales and Northern Ireland.

While in 1996 almost 6.5 million households in the whole UK were fuel poor (5m fuel poor vulnerable households), numbers decreased to 2 million in 2003 (1.5 m vulnerable households) and increased again to 4m (3.25m vulnerable households) in 2007 (Fuel Poverty Advisory Group, 2009). A similar development can be observed for energy spending over income shares for different household types. Using the BHPS data we compare income, and energy spending as a share of income for the whole sample as well as for different subsets of households:

- 'Low income' households are defined as having an income below 60% of median income in the sample. Since the survey does not provide information on disposable income (used in the official definition of low income households) we use annual household income instead. At the same time, we ensure that observations from this group do not overlap with any other social groups in focus.
- 'Pensioner' households are defined as those with a retired head of household. These households might also be low income households.
- 'Supported' households are those who receive income supports or jobseeker's allowances. These households might be on low incomes but do not include female single parents or pensioners.
- 'Female single parent' households have a female single parent and at least one child. These households might be on low incomes as well but are not retired or recipients of income supports or jobseeker's allowances.

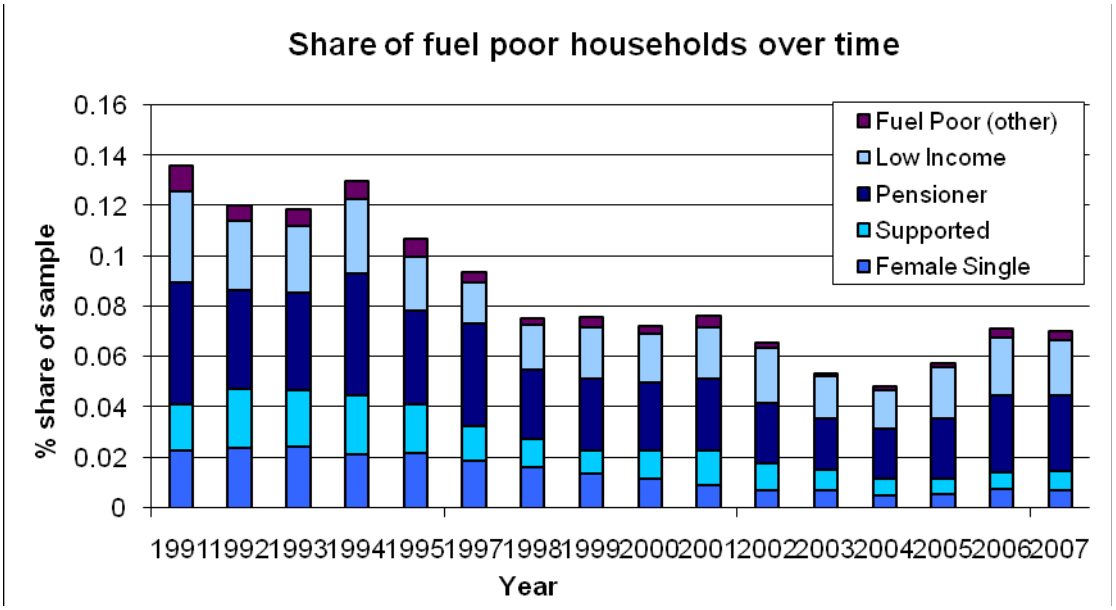

Fig. 2: Share of fuel poor households subdivided into vulnerable groups.

Source: Own presentation, based on BHPS data

Figures 3 to 6 show how income levels and energy spending shares have developed over time. The average household income for the whole sample has increased from £21,370 in 1991 to £29,000 in 2007 (in 2005 prices) though it stagnated in 2005/06. The share of energy spending over income was highest for all households in 1991 (3.4%), lowest in 2003 (2.4%) and reached 2.9% in 2007. Figure 3 shows similar developments for low income households though income levels are at much lower levels and % energy spending shares much higher.

For Pensioners (Figure 4) and income support (IS) and job seekers allowance (JSA) recipients (Figure 5) similar movements are observable although the difference in income levels and spending shares is not as high for low income households. Female single parent households show a rather strong course in particular (Figure 6), and their income decline after 2005 is comparatively high. Pensioner households and female single headed households with children form a high proportion of low income households. However, the average disposable income for these households decreased by 1% in 2005/06 and in 2006/07. Real income from benefits did not increase and this might explain the strong reduction in income for female single parent households as they were not compensated by a real increase in child benefit or education benefit they receive (Jones et al., 2008).

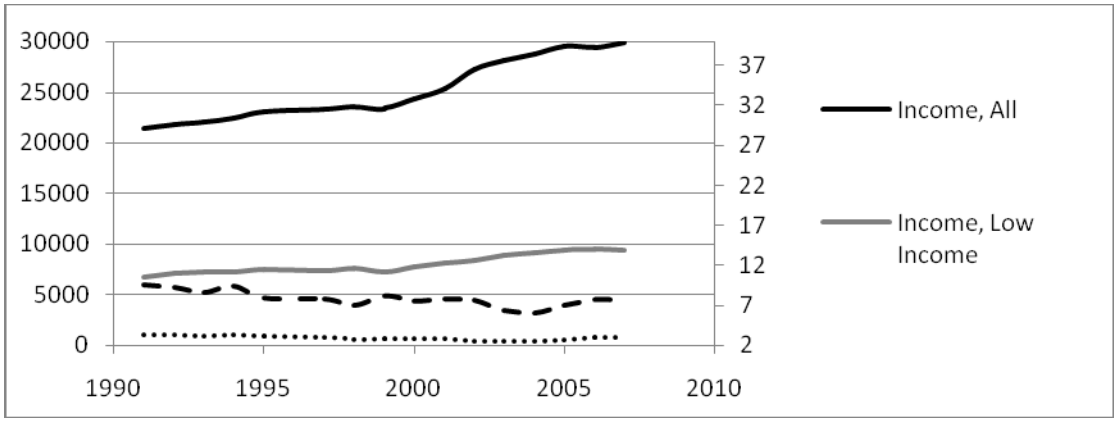

Fig. 3: All and Low Income Households

Source: Based on BHPS data

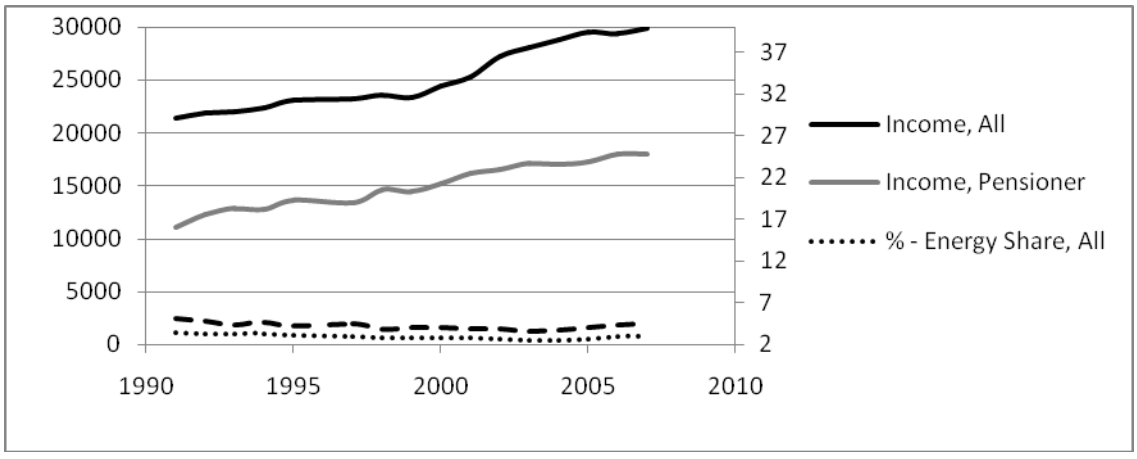

Fig. 4: All and Pensioner Households

Source: Based on BHPS data

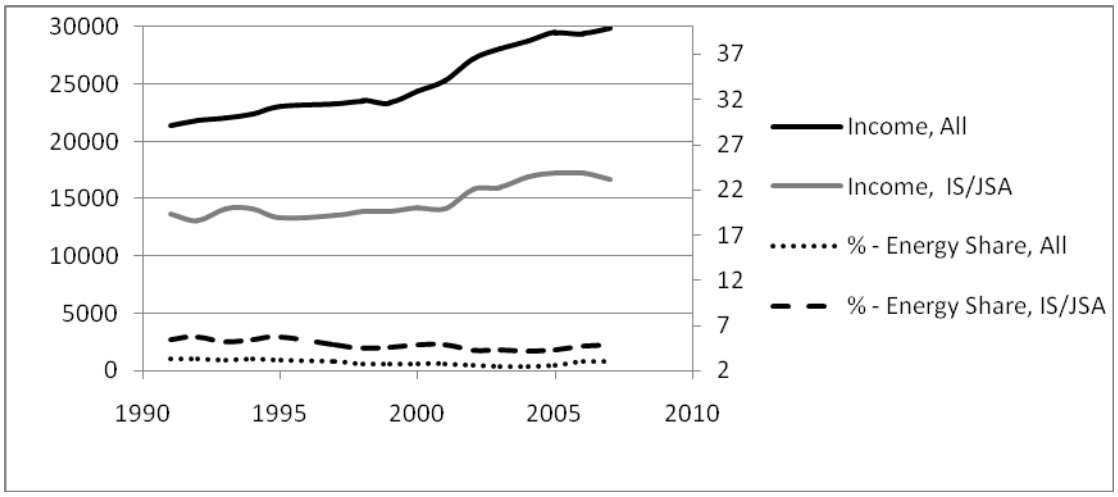

Fig. 5: All and IS/JSA Recipient Households

Source: Based on BHPS data

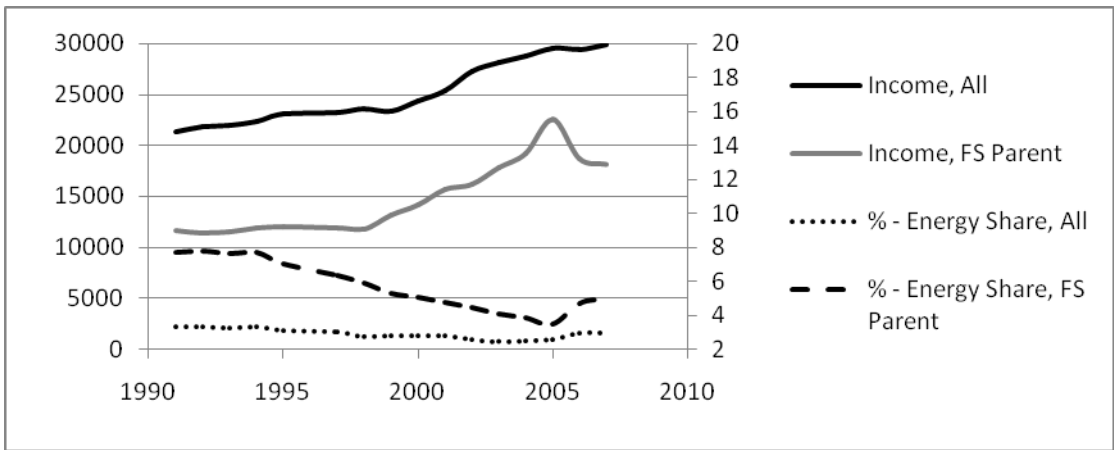

Fig. 6: All and Female Single Parent Households

Source: Based on BHPS data

6. Drivers of Fuel Poverty

Following the above descriptive results we present an empirical analysis using the BHPS data and explore the drivers of the fuel poverty ratio, i.e. of the energy spending over income share. In our model we control for price impacts, socio-economic characteristics such as household size and ownership of a property, the development over time, different building types and for the different vulnerable household groups discussed above. Our findings show that the specific characteristics of these household groups have a positive significant effect on their energy spending over income share. In other words, these household groups have higher energy spending over income shares independent of the other variables that we control for within our model. Among these

household groups, low income households in particular tend to have the highest energy spending over income share.

Table 1 summarizes some household characteristics of the specific groups of households. It shows that different vulnerable households are rather heterogeneous. As depicted in the table, fuel poor households belonging to any of the vulnerable household groups on average have lower incomes and at the same time higher levels of energy spending than the average (not fuel poor) household in the sample.

There are some possible explanations for the higher energy spending levels among these households. For example, households living in poorly insulated accommodations are at a higher risk of fuel poverty. It has been shown that households on low incomes live to a large extent in homes with poor energy efficiency (Palmer et al., 2008). In order to maintain an adequate level of warmth at home the households have to pay larger than average energy bills (Roberts, 2008). Moreover, low income levels contribute to a lack of capital which would be necessary to pay for insulation measures to improve the energy efficiency of heating systems.

Mean values								
	INCOME (£ p.a.)		ENERGY (£ p.a.)		AVERAGE AGE	HHSIZE	CHILDREN	ROOMS	SHARE (in whole sample) %
Whole sample	25,671		728		44	2.5	0.6	4.4	100
Whole sample, fuel poor	6,797	(26.5)*	1,021	(140.3)	49	2.0	0.5	1.8	8.06
Low Income	8,178		624		44	1.8	0.3	1.6	7.27
Low Income, fuel poor	5,830	(71.3)	960	(153.8)	43	2.1	0.5	1.8	2.16
Retired	14,839		620		70	1.6	0.0	4.1	27.12
Retired, fuel poor	6,207	(41.8)	876	(141.2)	72	1.3	0.0	4.1	3.05
Supported	14,879		713		37	2.6	0.7	3.8	6.25
Supported, fuel poor	6,211	(41.7)	954	(133.7)	40	1.9	0.5	3.6	1.22
Female single	15,459		783		19	3.0	1.7	1.3	5.92
Female single, fuel poor	6,996	(45.3)	1,073	(137)	17	2.9	1.8	4.1	1.25

Table 1: Mean values for different household types

Source: BHPS survey data

*Numbers in brackets: Percentages of income (energy spending) of different groups of fuel poor households in relation to overall income (energy spending) in different groups of households, f. e. 26.5 = (6,797/25,671)*100.

Another reason for higher energy spending among these groups of households is their actual use of energy. Besides the energy used for heating which makes up the largest share of a household's energy consumption, electricity is needed for lightning and appliances. The amount of electricity used per unit of energy service tends to be higher for fuel poor households as they tend to have older and less energy efficient appliances than higher income households. A major

reason for this is that some fuel poor households often buy second hand appliances rather than new appliances that comply with the highest energy efficiency standards (Boardman, 2010).

Moreover, not all households have access to all different fuels. In particular some households living in rural areas partly do not have access to gas and only use electricity, even for heating purposes. These households are likely to pay higher electricity prices than households that have access to both fuel types (Jamasb and Meier, 2010). Fuel poverty rates in rural areas are in general higher than in urban areas as houses in these areas tend to be larger but at the same time less energy efficient (Boardman, 2010).

In addition, different payment methods can also be a reason for a higher probability of some household types being affected by fuel poverty. For example, households using prepayment metres tend to pay more for each energy unit than households who pay by direct debit (Bennett et al., 2008). Finally, low income households might also have high energy bills because of a large number of family members who use many appliances. In contrast, single person households have a higher risk of being affected by fuel poverty (Palmer et al., 2008). In these households relative energy costs per capita are much higher because single persons live on their own (Boardman, 2010). Overall, our findings indicate that energy spending over income share decreases in the household size.

7. Discussion and Conclusions

As discussed above, low income households, pensioners, benefit recipients, and female single households spend significantly more of their incomes on energy in comparison to other households. In particular, low income households differ most from all other households. Firstly, this can be explained by three arguments: vulnerable households live on lower than average incomes and in order to reach a certain level of comfort or to heat their homes adequately they need to spend a larger share of their income on energy. A second reason could be that these households spend more time at home than households that consist mainly of full time workers and thus use more energy than others. The third reason may be that these households are not able to improve the energy efficiency of their homes. Thus the energy efficiency of their homes is lower and their energy using appliances may be less efficient.

Independent from reasons that cause higher energy spending to income shares, these higher spending shares are directly linked to these households being more severely affected by energy price increases. However, it is not the actual percentage of energy spending over income share that matters in this context. Rather, it is the household type that often appears to predetermine a worse than average outcome in energy spending and in particular the degree of affliction by energy price increases.

Different approaches are now undertaken to reduce energy bills of these consumers and to reduce fuel poverty and help vulnerable households. One such recent development affecting all customers is the government's plan to introduce smart meters for all electricity customers in the coming 10 years. Next to financial support paid to vulnerable households and in particular elderly people,

smart metering and social tariffs can play an important part in the public debate on eradicating fuel poverty and helping the vulnerable households. Smart metering can provide consumers with information on the actual energy consumption and might lead to behavioural changes. At the same time, energy suppliers no longer have to estimate bills, servicing costs can be reduced and thus there are potential consumer benefits.

Since many low income households only have access to electricity the introduction of smart meters can help these households as smart meters can provide information on usage patterns while benefits from time-of-use tariffs can be realized. Low income households and single parent households use prepayment meters to a larger extent which are more costly. Introducing smart technologies can contribute to reduction of energy bills. In addition smart meter technologies can facilitate switching of suppliers and lead to lower energy bills for vulnerable households (Owen and Ward, 2007).

Some combined efforts are undertaken by the Government, energy suppliers and Ofgem. The 'Smart Metering Implementation Programme' is a joint approach by DECC and the energy regulator. They focus on standardisation and co-ordination to promote competition and enable consumers switching suppliers easily. At the same time the creation of innovation incentives for energy suppliers is aimed at offering products and services meeting the needs of consumers (DECC and Ofgem, 2010). Also, the extension of the gas networks is part of measures undertaken by the regulator to help fuel poor households without access to gas. In additions, some grants are available for installation of efficient gas central heating and gas appliances (Ofgem, 2010).

The impact of the further changes and new technologies such as smart meters on vulnerable households needs to be carefully examined and in particular behavioural changes need to be accompanied by measures to improve energy efficiency of homes. Decision makers should pay ample attention to equity aspect of the expected future price increase that will affect certain households more severely and could widen the existing "energy gap" and inequality among households.

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