seai SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Combat Poverty Agency working for a poverty-free Ireland

Effectiveness of Domestic Energy-Efficiency Programmes

Fuel Poverty Action Research
Report 5:
Household Expenditure on Fuel and Electricity

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Context and Rationale

Despite an extensive literature in the UK and an increasing awareness of the issue, research into fuel poverty and domestic energy efficiency remains relatively scarce in Ireland. This is particularly the case for ex post analysis of domestic energy-efficiency programmes aimed at reducing fuel poverty among low-income households. To address this gap, Combat Poverty and Sustainable Energy Ireland developed a fuel poverty action research project to inform public policy on the merits of domestic energy-efficiency programmes. A particular focus of this project was to assess the economic impacts of the SEI-administered Warmer Homes Scheme which retrofits private homes with insulation and other energy-saving measures. The study was set in Cork City and County Donegal.

Scope of the Study

A key aspect of the study was to examine the impact of installing a range of energy efficiency measures on households.

Given the resources available, the study is based on a relatively small sample of 600 households – 247 households who had energy-efficiency measures installed under the Warmer Homes Scheme and a comparison group of 353 households who were not included in the initiative. It is important to state that the research has not been operationalised as a 'case control' study given the problems in matching households on specific criteria.

The study is set in a community development context, with local organisations in Cork City (Northside Community Enterprises Ltd) and County Donegal (Meitheal Forbartha na Gaeltachta) contributing to study design and implementation, including the conduct of all survey fieldwork on the study. Involving local communities in implementing the study was an important element of the implementation process, with these communities provided with an opportunity to further develop and build social value and capacity within their respective areas.

Fuel Poverty in Ireland

Boardman (1991) defines fuel poverty as 'the inability to heat one's home to an adequate (i.e. safe and comfortable) level owing to low household income and poor, energy inefficient housing and also the need to spend greater than 10 per cent of household income on fuel to achieve an acceptable level of comfort and amenity'. This definition is commonly accepted and reflects the close relationship between low household income, poor energy efficiency and household comfort. Applying this expenditure method of measuring fuel poverty, research by the ESRI (2008) estimated that 19 per cent of Irish households (301,368) may have experienced fuel poverty in 2008. Fuel poverty can also be measured using self-reported subjective measures such as being able to heat one's home to a temperature that is comfortable in winter. Again using this measure the ESRI (ibid) estimated that 3.6 per cent of Irish households (56,047) had experienced fuel poverty in 2007 [Note that these figures are estimates given that data on fuel poverty are not routinely collected by government in Ireland].

In addition to using the expenditure measure to assess the level of fuel poverty, subjective self-reported indicators of fuel poverty have also be used. Using a range of surveys (European Community Household Panel (1994-1997), Living In Ireland Surveys (1998-2001) and the EU

Survey of Income and Living Conditions (2003-2006) shows the proportion of households reporting that they could not afford to heat their homes properly falling from 8 per cent in 1994 to 4.6 per cent in 2006. Applying the self-reported subjective measure records a lower level of fuel poverty compared with the expenditure measure.

The Policy Response to Fuel Poverty

It is commonly recognised that three main factors influence the level of fuel poverty: fuel prices, household income, and energy efficiency of the housing stock. The relative importance of each factor depends on the period being examined, but by way of an example, the Scottish Executive (2008) reported that between 1996 and 2002 the reduction in fuel poverty is mainly attributable to increases in household income (50 per cent), and decreasing fuel prices (35 per cent), with energy efficiency improvements playing a lesser role (15 per cent).

At a policy level, there is strong evidence of an increased government commitment to tackling fuel poverty which is reflected in a number of key policy documents including the National Action Plan for Social Inclusion (2007-2016), the Government White Paper Delivering A Sustainable Energy Future for Ireland (2007-2020), the National Energy Efficiency Action Plan (NEEAP) 2009-2020 and the Programme for Government. Finally, in relation to the Warmer Homes Scheme there has been an increased budget allocation to the initiative year-on-year since its commencement in 2000.

In acknowledging that fuel poverty has significant impacts on the lives of people affected (e.g. comfort, health status, quality of life etc), and a disproportionate impact on low-income households, SEI set up a Low Income Housing Programme to help establish and implement a national plan of action to systematically address the problem of fuel poverty. The Programme is based on the premise that low-income households are unable to afford the capital investment measures to improve the energy efficiency of their homes. Allied to this point SEI acknowledges that 'income supports and fuel allowances do not address this structural deficiency in this part of the housing stock'. To address these concerns the Warmer Homes Scheme was developed and implemented.

The Warmer Homes Scheme

The Warmer Homes Scheme was set up as the core delivery vehicle for addressing fuel poverty within low-income households. The core aim of the scheme is:

> *... to improve the energy efficiency and comfort conditions of homes occupied by low-income households, and to establish the systems and growing the capacity in Ireland to install such measures.*

The scheme is implemented through a social employment model, with regional community-based organisations appointed to carry out remedial works which includes: attic insulation, draught proofing, lagging jackets, energy-efficient lighting, cavity wall insulation and energy advice. Eligible homes are identified locally via networks drawn from the statutory and voluntary sectors. The scheme is directed at privately owned and rented homes, which are more diverse and difficult to access than local authority homes, with the latter catered for elsewhere. The scale of activity each year is dependent upon available funding and is targeted at specific geographical areas. By 2008, €10.93m had been allocated to the scheme which covered interventions in 17,662 households (source: Sustainable Energy Ireland).

Linking the Warmer Homes Scheme with the Study

The Warmer Homes Scheme was identified as an appropriate vehicle for identifying households to take part in the study. Given that community-based organisations had already been contracted to retrofit households as part of the Warmer Homes Scheme, it was agreed that involving these same organisations would be an efficient way of implementing the study because of the close association between the organisations and the local community (i.e. established credibility, local contacts, mitigating problems associated with accessibility etc).

Literature Review

The literature suggests that fuel poverty is strongly affected by current expenditure and capital. In relation to current expenditure, the volatility of input prices which are largely determined by international markets '... means that in addition to households that are currently fuel poor at any given time, a significant number of additional households may be vulnerable to becoming fuel poor as prices fluctuate' (ESRI, 2008). In relation to capital, the ESRI posits that household expenditure on fuel is determined by the efficiency of appliances and the presence of energy-saving features in households. Brophy's (1999) definition of fuel poverty reflects both of these contributory factors:

> *The inability to heat one's home to an adequate (safe and comfortable) standard owing primarily to low income and poor (energy inefficient) housing standards.*

Within the Irish context, the Warmer Homes Scheme is the main policy response aimed at improving the capital housing stock of lower income groups, with the National Fuel Allowance and Electricity/Gas Allowances aimed at supporting expenditure on fuel among lower-income groups.

Impact of Fuel Poverty on Household Expenditure

The Institute of Public Health in Ireland (2007) points to a number of indirect effects associated with fuel poverty including people cutting back on spending on food, clothing and transport in order to heat their homes. According to the Institute other indirect effects include utility debt and 'spatial shrink' (Department of Social Development NI, 2003) where fewer rooms are occupied in order to save on fuel. These factors can contribute to social isolation and overcrowding and can be significant factors in driving low-income families into poverty and social exclusion. Research (Brown et al, 2004) shows that particular groups are particularly vulnerable to fuel poverty such as households comprising older people, young children and those with disabilities. Fuel poverty has also a disproportionate effect on low-income households of all ages and lone parent families (Healy, 2004). It is estimated that the risk of fuel poverty in Ireland rises exponentially when household income falls below €30,000 (Sustainable Energy Ireland, 2003).

Energy Use

The provision of energy-saving technology to the intervention group might be expected to result in changes in the use of energy or in the consequences arising from differential energy use, relative to the comparison group. These differences should be set against (added to) the cost associated with providing the intervention so the net discounted cost over the lifetime of the intervention can be calculated.

Three areas wherein differences might be expected as a result of the intervention are with regard to household fuel consumption, health-care consumption and food consumption. To take these very briefly in turn, in respect of fuel consumption, *a priori* one might expect the installation of energy-saving technology to result in relative savings in the use of fuel for intervention households relative to comparison households, as the former homes become easier to heat. In respect of health service use, in as much as inadequate heating may adversely affect health and thereby the demand for health services, one again might expect the installation of energy-saving technology to result in relative savings for the intervention group compared to the comparison group. Finally, in respect of food consumption, in as much as inadequate heating may require additional calorific intake to maintain body temperature, on the part of residents, again the installation of energy-saving technology might be expected to result in savings for the intervention relative to the comparison group.

Caution is warranted with respect to each of the hypotheses outlined here, however. Any changes in household energy use or efficiency will be the result of complex interactions likely to vary across households of different size and type. Households who achieve greater energy efficiency, for example, may choose to heat more of their home than was formerly the case or continue to use the same amount of energy to achieve more comfortable conditions rather than reduce overall fuel consumption – this may be particularly so for larger households where privacy may be at a premium. This phenomenon is referred to as 'comfort taking'.

Clinch and Healy (2003) modelled and valued the improvements in thermal comfort arising from an ex ante energy-efficiency retrofitting programme in Ireland. The model sought to predict the extent to which energy/emissions savings might be foregone in exchange for improvements in comfort/health. This approach estimated that over a 20-year period a total of €461 is foregone. Also the model predicted an increase in average household temperatures of 2.9 °C, from 14.8 to 17.7 °C. Clinch and Healy (ibid) concluded that '... it is clear that both the private and external benefits of such retrofitting schemes are very substantial. However, it is also clear that there are many households who, for a variety of reasons, either cannot or do not undertake retrofits. It is, therefore, important to correct this market failure through some form of intervention. The provision of grant schemes to low-income households combined with a thorough information campaign highlighting the cost-effectiveness of energy-efficiency retrofits and minimising transactions' costs should be undertaken by the State.'

Similarly, within the data, the potential for outliers to exert considerable influence on averages should be borne in mind. Given the high costs of inpatient care, for example, a prolonged hospitalisation for just one member of either intervention or comparison groups unrelated to energy use could dominate other costs and give a misleading impression of the impact of the intervention.

With these caveats in mind the investigation of the impact of the intervention adopted a difference in differences approach – how do differences between baseline and follow-up compare between the two groups. It was not possible to pursue possible changes in food expenditures given the data available in the survey and these were therefore set to one side. Changes in fuel consumption were measured for each group related to self-reported total fuel bills in the year in question. In relation to health service use, the survey captured self-reported use of a range of services. Differences were examined in respect of GP, inpatient, outpatient and A&E service use. Where the survey afforded the respondent only a categorical response (for example did you use outpatient services – yes or no?) the number of visits was estimated using published sources for a representative sample of the Irish population. A similar approach was adopted in respect of inpatient stays. Utilisation was then monetised through UK reference costs converted to Euro using an exchange rate of £0.85p sterling to 1 euro.

It is acknowledged that this approach is not unproblematic. For example, differences in the unit cost of health care may well exist between Ireland and the UK (an outpatient visit may cost more in Ireland compared to the UK, for example). Similarly, the pattern of service use among this group of respondents might differ from that observed nationally. In the absence of other data, however, the values presented remain best estimates. Moreover, in as much as the same approach is adopted in respect of comparison and intervention groups, the potential for systematic bias should be reduced.

Data Collected

To evaluate the impact of the various programme interventions on household expenditure on fuel and electricity a range of data was collected on energy use and expenditure including: heating system used; types of fuel used; home heating bills in winter and summer; and access to fuel subsidies.

Findings

Fuel Expenditure

Applying a difference in differences approach (i.e. how do differences between baseline and follow-up compare between the two groups) the study found that although annual expenditure on fuel fell for both the intervention (-€84.44) and comparison (- €85.83) groups, the difference between the two groups was not found to be statistically significant. As noted previously market prices will impact on household expenditure on fuel, with the volatility in international oil prices in particular likely to have had some impact on household fuel expenditure behaviour.

A multivariate regression was carried out on the total household fuel costs per room at the time of the follow-up survey in comparison to the baseline survey. A full list of the independent variables is included in Table 1. Note that independent variables significantly associated with the dependent variable are highlighted with an asterisk. The model produced an r-squared figure of 0.009 which means that the model explained less than 1 per cent of the variation in the dependent variable (i.e. difference in total fuel costs per room).

Once the effects of the age of the house, whether the house was detached, whether the house had central heating at the time of the follow-up, the measured temperature at the time of the follow-up survey, the number of energy efficiency upgrades made between surveys and the amount of fuel subsidy, households in the intervention group were not significantly more likely than those in the comparison group to have made a fuel saving. Indeed none of the variables was found to affect fuel cost savings significantly.

Table 1 Regression analysis of difference between baseline and follow-up surveys in total fuel costs per room

Variable	Standardised regression coefficient[1]
Household in intervention group[2]	0.170 ns
Detached house[3]	-0.031 ns
Age of house	-0.057 ns
House has central heating	0.026 ns
Amount of fuel subsidy	-0.157 ns
Temperature at time of follow-up interview	-0.010 ns
Lagging jacket installed	-0.130 ns
Loft, attic or ceiling insulation installed	-0.106 ns
Floor insulation installed	0.044 ns
Wall insulation installed	-0.002 ns
Double glazing installed	-0.069 ns
Door draught-proofing installed	-0.184 ns
Window draught-proofing installed	-0.163 ns
Central heating controls or timer installed	0.131 ns
Low energy light bulbs installed	0.031 ns
Index of no. of energy-saving devices	0.378 ns

ns = Not significant, * = p < 0.05; [1] A negative coefficient indicates a lower overall fuel cost at the time of the follow-up survey; [2] Comparator is household is in the comparison group; [3] Comparator is terraced house.

Health Expenditure

The survey also assessed changes in health expenditure. As can be seen from the table, while there are differences between the two groups, except for hospital inpatient admittance, none of these differences is statistically significant. In respect of the significant difference – savings for inpatient hospital admittance (and also the non-significant difference for total health costs) – that the value attributed to the comparison group appears greater than that among the intervention group is counter-intuitive. In respect of inpatient stays where savings were significantly greater ($p < 0.05$) among the comparison group, the intervention group actually reported higher inpatient costs at the time of the follow-up survey. (In respect of this value in particular care is warranted for the reasons outlined above.)

Table 2 Economic Impacts (Savings)

Annual estimated cost related to	**Mean difference baseline to follow-up (Euro)**	
	Comparison	**Intervention**
GP	**- €19.69**	**- €32.57**
Outpatient	**- €9.47**	**- €16.38**
A&E	**- €0.89**	**- €4.94**
Inpatient*	**- €136.64**	**€94.55**
Total estimated health costs*	**-€166.69**	**€40.66**

***Indicates Statistically Significant (p<=0.05)**

A multivariate regression incorporating the effects of 'life style' variables was also carried out on the estimated inpatient hospital cost savings to see whether the greater savings observed for the comparison group would prove robust. They did not. In fact, none of the 'life style' or associated variables proved to have a uniquely significant effect upon change in inpatient costs between the times of the baseline and the follow-up surveys.

A full list of the independent variables is included in Table 3. Note that independent variables significantly associated with the dependent variable are highlighted with an asterisk. The model produced an r-squared figure of 0.08 which means that the model explained just 8 per cent of the variation in the dependent variable (i.e. difference in health costs between baseline and follow-up).

Table 3 Regression analysis of difference between baseline and follow-up surveys in inpatient health costs	
Variable	**Standardised regression coefficient[1]**
Current smoker	-0.050 ns
Moderate exercise	0.135 ns
Mild exercise	-0.180 ns
General drinking	0.149 ns
Drinking spirits	0.124 ns
Nutritious eating	-0.215 ns
Non-nutritious eating	-0.131 ns
Long-standing illness worse than a year ago	-0.225 ns
Age	-0.392 ns
Body Mass Index (BMI)	-0.042 ns
Male	0.473 ns
Intervention group[2]	0.013 ns

ns = Not significant; [1] Positive coefficient indicates higher inpatient costs at the time of the follow-up survey; [2] Comparator is household is in the comparison group

Expenditure by Fuel Type

The follow-up survey found a reduction in the average spend on central heating oil by both intervention and comparison households, although the fall in spend among comparison households was statistically significant (p<=0.05) whereas this was not the case in intervention households. In contrast, average expenditure on coal fell significantly among intervention households at follow-up (down from €427 to €298) whereas the fall in expenditure on coal was not statistically significant among comparison households. Finally, although both intervention and comparison households reported a fall in expenditure on gas canisters, these changes were not statistically significant.

Table 4 Average Expenditure On Home Heating Fuels Used In Last 12 Months n=600				
	Intervention Baseline	**Intervention Follow-up**	**Control Baseline**	**Control Follow-up**
	Average €	**Average €**	**Average €**	**Average €**
Central heating oil	873	801	904	800
Coal	427	298	399	344
Gas Canister	141	113	165	124

Highest Home-Heating Bill in Winter

Households were asked to indicate typically what their highest home-heating bill is in winter (not including HP payments, maintenance or repairs). Among intervention households the highest average bill between baseline and follow-up fell, from €376 to €227 ($p<=0.001$). Among comparison households the average spend on the highest home-heating bill in winter also fell, from €327 to €277 ($p<=0.05$). Note that the reduction among intervention households was larger and recorded a higher level of statistical significance.

Lowest Home-Heating Bill in Summer

As with home-heating bills in winter, the pattern was consistent when households were asked about expenditure on fuel in summer. Among intervention households, the average expenditure on the lowest bill in summer fell significantly, from €137 at baseline to €68 at follow-up ($p<=0.001$). In contrast, there was no significant fall in the average lowest home-heating bill in summer among comparison households (up from €95 to €103).

Paying Utility Bills on Time

All households were asked to indicate how easy or difficult they find it to pay their utility bills on time. The proportion of intervention households finding it difficult or hard to pay their utility bills on time fell significantly, from 48 per cent at baseline to 28 per cent at follow-up ($p<=0.001$), whereas there was no significant change recorded among households in the comparison sample (42 per cent at baseline compared with 40 per cent at follow-up).

A multivariate regression was carried out on whether households found it easier to pay their utility bills on time at the time of the follow-up survey in comparison to the baseline survey. A full list of the independent variables is included in Table 5. Note that independent variables significantly associated with the dependent variable are highlighted with an asterisk. The model produced an r-squared figure of 0.016 which means that the model explained just 2 per cent of the variation in the dependent variable (i.e. variation in paying utility bills on time).

Once the effects of whether the house was detached, whether the house had central heating at the time of follow-up, the measured temperature at the time of the follow-up survey, the difference between measured temperatures at the time of the follow-up and the baseline surveys, the total number of rooms in the house and the amount of fuel subsidy – plus an index of the number of fuel efficiency devices installed between the two survey dates, along with the varieties of fuel efficiency devices: hot water tank lagging; loft, attic or ceiling insulation; floor insulation; wall insulation; double glazing; door draught-proofing; window draught-proofing; central heating timer or controls; low-energy light bulbs – households in the intervention group were not found to be more likely than those in the comparison group to report that they now found it easier to pay their utility bills on time. The only significant effect was ($p < 0.05$) if households had installed wall insulation.[1]

1 The other variables – detached house or not, central heating or not, measured temperature at time of follow-up survey, difference between measured temperatures at baseline and follow-up surveys, total number of rooms in the house, amount of fuel subsidy and all of the other energy efficiency devices – are not significant.

Table 5: Regression analysis of extent to which households found it easier to pay utility bill by the time of the follow-up survey	
Variable	**Standardized regression coefficient**
Wall insulation installed	***0.135****
Household in intervention group[1]	0.094ns
Detached house[2]	-0.007 ns
Number of rooms in house	-0.062 ns
House has central heating	-0.043 ns
Amount of fuel subsidy	0.015 ns
Temperature recorded at time of follow-up interview	0.027 ns
Change in recorded temperature by time of follow-up survey	0.030 ns
Lagging jacket installed	***0.031 ns***
Loft, attic or ceiling insulation installed	***0.053 ns***
Floor insulation installed	-0.049 ns
Double glazing installed	0.000 ns
Door draught-proofing installed	***0.072 ns***
Window draught-proofing installed	***0.052 ns***
Central heating controls or timer installed	0.033 ns
Low energy light bulbs installed	***0.049 ns***
Index of no. of energy-saving devices	0.084 ns
Items in bold and italic relate to measures installed as part of the Warmer Homes Scheme.	

ns = Not significant, * = $p < 0.05$

[1] Comparator is household is in the comparison group

[2] Comparator is terraced house.

Temperature of Home in Winter and Affordability

Between baseline and follow-up, the proportion of intervention households who could afford to heat their households in winter, or more generally when it is cold, increased from 22 per cent to 52 per cent ($p<=0.001$). Although not as dramatic, the proportion of comparison households who indicated that they can afford to heat their households during winter also increased (up from 22 per cent to 43 per cent, $p<=0.001$).

Among intervention households, the increase in the proportion of households indicating that they could afford to heat their households during winter was more marked in Cork (up from 15 per cent to 60 per cent) compared with Donegal (up from 23 per cent to 47 per cent).

Again when households with children were considered, the results show that the interventions have had a positive effect. For example, the vast majority (93 per cent) of baseline intervention households with children reported difficulty in being able to afford to heat their homes to a comfortable temperature compared with 29 per cent at follow-up ($p<=0.001$). Among comparison households with children there was no significant change, with 71 per cent experiencing problems with affordability at baseline compared with 63 per cent at follow-up.

Conclusions

The evidence from this analysis shows that both the intervention and comparison households reported small savings of approximately €85 per annum on fuel costs at the time of the follow-up survey in comparison to baseline, with the difference in savings between the two groups negligible and not statistically significant.

In putting this finding in context it is important to acknowledge that during the study period there were variations in the cost of fuel, although both the intervention and comparison households would have been exposed to these variations. SEI has set out an overview of the price cost variations for domestic fuel (SEI – Archived Domestic Fuel Costs, 2009) between 1999 and 2009. This document shows that between October 2006 and January 2009 (study fieldwork period) there were increases in the price of all types of coal. The cost of kerosene dropped marginally from €0.58 per litre in October 2006 to €0.56 per litre in January 2009 although there were price spikes in this period (e.g. €1.04 in July 2008). Also, in relation to electricity, the standard rate rose from €0.14 per kWh in October 2006 to €0.19 per kWh in January 2009. The cost of a bale of briquettes rose from €3.20 to €3.85 and the standard rate for natural gas rose from €0.05 to €0.06 over the period.

In addition to changes in fuel costs, a number of social welfare changes were introduced including:

- an increase in the rate of the National Fuel Scheme by €4 per week, to €18, from January 2007

- an increase in the income threshold for entitlement to fuel allowances from €51 per week in excess of the State Pension (Contributory) rate to €100 per week in excess of that rate from January 2007

- increases in the maximum weekly personal rate for all State and related social insurance pensions (increased by €16 from the first week of January 2007), with an increase in the maximum personal weekly rate of the State Pension (Non-Contributory) by €18 from the first week in January 2007.

Of these policy changes an increase in the income threshold for fuel allowances is likely to have had some impact on fuel expenditure by households, which is evidenced by the significant increase between baseline and follow-up in the proportion of households availing of the fuel subsidy allowance.

Being able to afford to heat one's home in winter to a temperature that is comfortable is a subjective indicator of fuel poverty. The evidence from this study shows that based on this indicator there has been a significant improvement among households availing of energy efficiency measures under the Warmer Homes Scheme, with the majority of these households at follow-up (52 per cent) saying that they can afford to heat their homes compared with 22 per cent at baseline. Again in applying the affordability indicator, the evidence shows that households with children availing of measures under the Warmer Homes Scheme, compared with comparison households, were less likely to report problems with affordability at follow-up compared with baseline (down significantly from 93 per cent to 27 per cent).

Another indicator of economic impact is the fall in the highest average home-heating bill in winter which was recorded for both the intervention and comparison households, although the fall in average spend was more significant among the intervention households. Similarly in summer there was a significant fall in the average home-heating bill among intervention households, with no significant change among comparison households.

Combining the evidence of reduced expenditure on fuel bills, moderate savings on fuel expenditure and the policy changes introduced during the study period, it is not surprising to find a significant fall in the proportions of both intervention and comparison households who are finding it easier to pay their utility bills on time, which, using this measure, suggests a decline in fuel poverty.

The economic data from the research suggest little difference between baseline and follow-up in relation to savings on health-care expenditure. Differences in four types of estimated health costs between individuals in the intervention and comparison groups who answered both surveys – costs of GP visits; outpatient clinic attendance; A&E attendance; inpatient hospital admittance – were calculated. Only the estimated inpatient costs showed a significant difference, with the cost savings apparently only for the comparison group. However, this result vanished when subjected to a multivariate analysis incorporating the effects of 'life style' variables.

Overall the evidence from an economic analysis of the data points to a number of positive outcomes among the intervention households, particularly in relation to a reduction in fuel poverty using the indicator of being able to afford to heat homes to a temperature that is comfortable in winter. Although fuel expenditure fell marginally for both the intervention and comparison groups, future variations in the price of fuel are likely to have a disproportionate impact on low-income households which means that initiatives such as the Warmer Homes Scheme are likely to become more important in providing low-income households with greater opportunity to improve the thermal comfort of their homes and reduce exposure to the vagaries of volatile fuel markets.

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Appendix (Output from Multivariate Analysis)

Model 1

Regression analysis was conducted with difference in fuel expenditure between baseline and follow-up used as the dependent variable. The independent variables used in the regression were:

Intervention group (dummy)
Detached house (dummy)
Year house built
Central heating (dummy)
Receipt of fuel subsidy amount
Household temperature
Lagging jacket installed
Floor insulation installed
Loft insulation installed
Wall insulation installed
Double glazing installed
Door draught-proofing installed
Window draught-proofing installed
Low energy bulbs installed
Central heating controls installed
Increase in number of energy-efficiency devices between baseline and follow-up

This model produced an adjusted R Square of 0.009 which means that the model explained 0.9% of the variation in fuel expenditure between baseline and follow-up.

Model	B	Unstandardised Coefficients		Standardised Coefficients		
		Std. Error	Beta	t	Sig.	
1	(Constant)	-42.505	367.757		-.116	.908
	Intervention group (dummy)	179.088	99.109	.170	1.807	.073
	Detached house (dummy)	-63.889	180.420	-.031	-.354	.724
	Year house built	-12.525	19.834	-.057	-.632	.529
	Central heating (dummy)	63.825	213.691	.026	.299	.766
	Receipt of fuel subsidy amount	-.353	.218	-.157	-1.617	.108
	Household temperature	-6.031	52.773	-.010	-.114	.909
	Lagging jacket installed	-143.824	138.571	-.130	-1.038	.301
	Floor insulation installed	160.071	320.173	.044	.500	.618
	Loft insulation installed	-113.755	127.284	-.106	-.894	.373
	Wall insulation installed	-2.011	121.979	-.002	-.016	.987
	Double glazing installed	-103.186	164.776	-.069	-.626	.532
	Door draught-proofing installed	-197.916	130.190	-.184	-1.520	.131
	Window draught-proofing installed	-196.807	152.406	-.163	-1.291	.199
	Low-energy light bulbs installed	33.141	126.917	.031	.261	.794
	Central heating controls installed	198.282	164.248	.131	1.207	.230
	Increase in No. of energy efficiency devices between baseline and follow-up	99.104	73.492	.378	1.348	.180

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.345a	.119	.009	522.62921

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Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4716017.535	16	294751.096	1.079	.382a
	Residual	3.496E7	128	273141.289		
	Total	3.968E7	144			

Model 2

Regression analysis was conducted with difference in inpatient costs between baseline and follow-up used as the dependent variable. The independent variables used in the regression were:

Smoking status
Self reported health status
Age
Body Mass Index (BMI)
Male (dummy)
General drinking
Consumption of spirits
Avoids nutritious foods
Avoids non-nutritious foods
Intervention group (dummy)
Moderate physical activity
Mild physical activity

This model produced an adjusted R Square of -0.084 which means that the model explained 8.4% of the variation in inpatient costs between baseline and follow-up.

Model	B	Unstandardized Coefficients		Standardized Coefficients		
		Std. Error	Beta	t	Sig.	
1	(Constant)	-1931.536	2051.008		-.942	.352
	Smoking status	-72.629	223.374	-.050	-.325	.747
	Self reported health status	453.651	565.265	.163	.803	.427
	Age	-228.962	212.797	-.211	-1.076	.288
	Body Mass Index (BMI)	49.054	38.699	.197	1.268	.212
	Male (dummy)	383.205	445.436	.192	.860	.395
	General drinking	227.230	301.483	.149	.754	.455
	Consumption of spirits	147.011	215.174	.124	.683	.498
	Avoids nutritious foods	292.620	337.841	.215	.866	.392
	Avoids non-nutritious foods	127.038	191.937	.131	.662	.512
	Intervention group (dummy)	-117.722	536.796	-.050	-.219	.828
	Moderate physical activity	165.611	291.526	.135	.568	.573
	Mild physical activity	-228.930	263.610	-.180	-.868	.390

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.408a	.167	-.084	1045.92050

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Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8741651.601	12	728470.967	.666	.773a
	Residual	4.376E7	40	1093949.699		
	Total	5.250E7	52			

Model 3

Regression analysis was conducted with 'find it easier to pay bills now' used as the dependent variable. The independent variables used in the regression were:

Wall insulation Fuel subsidy amount
Number of rooms in house
Central heating (dummy)
Detached house (dummy)
Temperature at baseline
Temperature difference between baseline and follow-up
Intervention group (dummy)
Lagging jacket installed
Floor insulation installed
Loft insulation installed
Double glazing installed
Door draught-proofing installed
Window draught-proofing installed
Low-energy light bulbs installed
Central heating controls installed
Increase in number of energy-efficiency devices between baseline and follow-up

This model produced an adjusted R Square of 0.016 which means that the model explained 1.6% of the variation in 'easier to pay bills now' baseline and follow-up.

Model	B	Unstandardized Coefficients		Standardized Coefficients		
		Std. Error	Beta	t	Sig.	
1	(Constant)	.111	.049		2.284	.023
	Wall insulation	.239	.085	.135	2.809	.005

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.135a	.018	.016	.82550

a. Predictors: (Constant), Wall Wall insulation installed

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Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.376	1	5.376	7.889	.005a
	Residual	290.294	426	.681		
	Total	295.671	427			

a. Predictors: (Constant), Wall Wall insulation installed
b. Dependent Variable: easier Easier to pay for fuel now? (N > 1 = YES)

Excluded Variables[b]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
					Tolerance	
1	Fuel subsidy amount	.015a	.311	.756	.015	1.000
	Number of rooms in house	-.062a	-1.294	.196	-.063	.996
	Central heating (dummy)	-.043a	-.880	.379	-.043	.988
	Detached house (dummy)	-.007a	-.147	.883	-.007	1.000
	Temperature at baseline	.027a	.551	.582	.027	.952
	Temperature difference between baseline and follow-up	.030a	.614	.539	.030	.959
	Intervention group (dummy)	.094a	1.913	.056	.092	.945
	Lagging jacket installed	.031a	.648	.518	.031	.976
	Floor insulation installed	-.049a	-1.025	.306	-.050	1.000
	Loft insulation installed	.053a	1.102	.271	.053	.995
	Double glazing installed	.000a	-.015	.988	.000	.998
	Door draught-proofing installed	.072a	1.506	.133	.073	.999
	Window draught-proofing installed	.052a	1.078	.282	.052	1.000
	Low-energy light bulbs installed	.049a	1.015	.311	.049	.980
	Central heating controls installed	.033a	.686	.493	.033	1.000
	Increase in number of energy-efficiency devices between baseline and follow-up	.084a	1.640	.102	.079	.866