EC331
Research in Applied Economics

The Winter Fuel Allowance and pensioners: Warming the home or cold comfort?

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Abstract

Using the British Household Panel Survey and the Expenditure and Food Survey, this paper examines the effect of the Winter Fuel Allowance and methods of payment for fuel on fuel expenditure. Prospect theory and mental accounting are applied to the field of public economics as has not been the case before. Evidence shows £6.20 of the Allowance is worth as much as £1 of any other income in influencing fuel expenditure decisions. This is evidence against the concept of having a Winter Fuel Allowance; as well as against mental accounting theory that says labelling a payment in a certain way should stimulate recipients to integrate that money into the mental account recommended by that labelling. However, it is argued this effect can only be robustly tested if the Allowance was greater than fuel expenditure. Additionally, preferences for methods of payment vary for different income groups. Those with higher incomes prefer to maximise hedonic efficiency, while poorer or more loss-averse households underconsume fuel by choosing to couple payments with consumption more tightly.

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The Winter Fuel Allowance (WFA) is a government transfer paid to people aged 60 and over. It is paid every November in addition to other pension transfers. It was introduced to help tackle perceived pensioner underconsumption of fuel, characterised by the high incidence of excess winter fuel deaths amongst the elderly in Britain compared to the rest of Europe. Since the money can be distributed more easily in other, more cost-efficient ways, there cannot be an economic justification for such a transfer under the normal Hicksian demand framework. However, the government must see transfer *t* of WFA as having a greater impact on fuel expenditure than, say, adding *t* onto the Basic State Pension (BSP). Labelling a payment thus must influence consumption decisions in a way not captured by conventional economics. Why else would the government adopt a measure that incurs it at least five percent in extra costs to implement,[1] even though it is essentially a free cash payment that can be spent on anything? That it is free cash makes this analysis distinct from that on food or education vouchers widely considered successful in the USA. The paper also analyses the way households pay for their fuel, and tests mental accounting theory on what determines choices whether to pre- or post-pay. The conclusion is that the free cash element of it, alongside its payment in November or December, prompt pensioners to use the money for uses other than fuel. Additionally, distinct types of consumers prefer the different payments options available.

Most pensioners receive their payments automatically if they received a payment last year and their circumstances have not changed. Although its introduction in 1997 saw some recipients receive only £20, since then it has evolved into a major piece of government expenditure, forecast to reach £1.9 billion in 2003-04. Currently, the WFA benefits around two million households.

	Number in receipt (thousand individuals)	Government expenditure (£ millions)	Rules for payment
1997-98	9,759	191	£20/household if they receive Income Support; £50 otherwise
1998-99	10,191	199	£20/household if they receive Income Support; £50 otherwise
1999-2000	10,225	774	£100/household
2000-01	11,123	1,749	£150/household
2001-02	11,202	1,682	£200/household
2002-03	11,322	1,710	£200/household
2003-04	na	1,900*	£200/household; £100 more if person is over 80 years of age
2004-05	na	1,900*	£200/household; £100 more if person is over 80 years of age

* predicted

Source: Munro (2005) and Hansard, 5th June 2000

Table 1: Winter Fuel Allowance: An introduction

Because it is universal, non take-up rates of the WFA are lower than with means-tested benefits, where pensioners are likely to feel stigmatised by receipt of these state "hand-outs", driving non take-up rates higher.[2]

[1] This cost reflects *only* the publicity campaign undertaken every year to inform people about the payment. The true costs are likely to be more than twice this. Source: Questions for Secretary for Work and Pensions, *House of Parliament minutes*, 8 December 2004 (Wicks to Webb).

[2] Additionally, a large proportion of pensioners have modest occupational pensions make them marginally ineligible for means-tested benefit entitlement.

Several medical articles advocate its age-contingent nature, adding that it should be aimed at especially women and people living alone (see for example Wilkinson *et al.* [2004]).[3]

There has been significant praise for the scheme from interest groups such as Help the Aged and it is popular in the pensioner community. It is not, however, to be confused with Cold Weather Payments, which is a flat-rate payment of £8.50/ week made to vulnerable groups for every week of continuously cold weather. Fuel poverty, defined as a household spending more than ten percent of their income on fuel, has been decreasing – in seven years from 1994-95, this proportion for the poorest 30 percent of households has fallen from 9.4 to six percent, although in the general population this has also fallen from 4.3 to 2.6 percent.[4] In the same period, real gas prices have fallen by 19 percent and electricity prices by 26 percent. Since then, as these prices have increased 11 and seven percent respectively, the number of vulnerable fuel poor has gone up by 400,000, although this has been offset by increases in income contributing to a decrease in fuel poor of 300,000.[5] Higher energy prices could force another 250,000 into fuel poverty during 2006, especially as fuel firms have announced severe price increases recently.[6] [7]

Much of the previous reduction in fuel poor households is "thought to be due to changes in incomes and energy prices." The cost of tackling fuel poverty could be as high as £3.2bn for 1.7m households (indicative maximum total cost from DTI (2003) plus their projected "further 20 percent overheads"). The introduction of the WFA was, in conjunction with a raft of measures such as free TV licenses and greater help towards home insulation for the poorest pensioners, intended to raise the living standards of pensioners.[8] This is often most acute for older pensioners. Wilkinson *et al.* show the probability of winter death amongst those aged 85-89 is three times as for those aged 75-79. Interestingly, they also show moderate consumption of alcohol cuts this probability substantially.[9]

The normal Hicksian demand function says demand depends on price and income, and is frame invariant. This paper shall relax this invariance assumption, by suggesting labelling a payment t as 'Winter Fuel Allowance' changes behaviour to stimulate greater expenditure on fuel than would otherwise be the case. We use Kahneman

[3] Until 1999 the allowance did favour women: it was available to men over 65 and women over 60, but following a ruling by the European Court of Human Rights, everyone over 60 is now eligible. Moreover, couples living together receive less per head than individuals.
[4] Fuel Poverty Monitoring – Indicators, DTI
[5] Fuel Poverty Advisory Group (for England) Third Annual Report 2004/5
[6] uSwitch, 'Energy bills to soar this Winter,' *Press Release*, 29th January 2006.
[7] In 2006, gas companies have announced the following increases in domestic gas (electricity) prices (figures in percentages): Powergen 24 (18), British Gas 22 (22), Scottish & Southern 14 (12), Npower 15 (14), EDF Energy 15 (5), Scottish Power 15 (8).
[8] DTI (2003), p.5. In fact, if instead of the £1.9bn spent on the WFA, the government spent this money on such measures for just fuel poor households regardless of age (they would be predominantly pensioners), it could provide draft proofing, loft insulation, cavity insulation, electric storage heaters and community heating for high-rise flats, solid wall insulation, boiler replacement, and oil-fired central heating for *all* those homes which required this, which would, according to official estimates, do more to tackle fuel poverty than the WFA income effects, if we base the WFA's success on the fuel poverty figures quoted above. Source: Table 3: *Measures needed in vulnerable fuel poor homes*, reproduced in Appendix 1.
[9] Wilkinson *et al.* (2004), Table 1, rate of death in winter (non-winter) months per 1000 person years for zero alcohol units/week: 113.5 (85.8); for 1-6 alcohol units/week: 84.6 (65.9).

and Tversky's prospect theory and Richard Thaler's mental accounting ideas in an area (public economics) largely ignored by behavioural economists, in Sections A. Section B considers a parallel explanation for the underconsumption of fuel suggested by Prelec and Loewenstein (1998) involving the trade-off between pleasure of consumption and pain of payment. Section C presents regressions looking at the actual WFA data, and we finish with suggestions for extensions and our conclusions in D.

SECTION A: THEORY: MENTAL ACCOUNTING

The impact of a £200 benefit on fuel expenditure is minimal under normal Hicksian conditions, where it would be interpreted solely as an age-contingent lump sum. Munro (2005) finds an income elasticity of fuel expenditure ε of only 0.28 using Expenditure and Food Survey (EFS) data for 2001-02 and Blundell *et al.*'s (1998) estimates imply a similar level. Therefore, for all agents concerned, adding (1.1)t to the BSP would lead to greater expenditure on fuel than having a WFA of level t, which incurs implementation costs of 0.1t.[10] Politicians' utility is a function of their citizens' utility. By introducing the latter rather than the former, utility for the government (and, by implication, for pensioners) must be greater through WFA than through an increase in the BSP. As Munro explains, there must be some bounded rationality on the part of both the players.[11]

The explanation analysed here is given by prospect theory, which shows how individuals evaluate gains and losses. Different consumption decisions are first ordered heuristically. Evaluations about losses and gains are then developed starting from a reference point (an outcome considered neutral/ normal, typically the status quo). The utility function passing through this point is s-shaped with concave positive and negative regions with different slopes, which indicate losses produce greater disutility than gains produce utility (loss aversion). Therefore frame invariance no longer applies.

We look at net utility for an individual, starting from:

$$\sum_{i=1}^{N} v(C_i) = v\left(\sum_{i=1}^{N} C_i\right) \qquad \text{under Hicksian framework} \qquad (1)$$

where $v(C_i)$ *= utility from consumption C of good i*

But now, having seen gains plateau quickly, while losses don't, the implication is:

$$\sum_{i=1}^{N} v(C_i) > v\left(\sum_{i=1}^{N} C_i\right) \qquad \text{under prospect theory framework} \qquad (2)$$

This shows that for consumption or gains in income, individuals would be better off by segregating their gains rather than integrating. Conversely for losses, they should integrate rather than segregate. Thaler (1985) shows four simple rules:

1. $v(x+y) < v(x) + v(y)$; *x, y gains*
2. $v(x+y) > v(x) + v(y)$; *x, y losses*

[10] Using the assumption from Footnote 1.
[11] Munro (2005), pp. 7-9.

3. *v(x+y) < v(x) + v(y)*; *x large gain, y small loss (mixed gain)*
4. *v(x+y) < v(x) + v(y x small gain, y large loss*

where v(x) + v(y) = utility from two goods consumer sees as separate transactions
v(x+y) = utility from two goods consumer sees as single, combined transaction

He says "if a gain can be broken down into smaller and smaller gains, utility can be still higher,"[12] because each small payment is transferred into mental accounts earmarked for certain activities i.e. a person subjectively frames a transaction in their mind, which then determines the utility they receive or expect. This suggests a pensioner income made up of a number of smaller transfer payments (BSP, WFA, Pension Credit, free TV licenses, free bus passes) gives greater utility than the same income made up of just one large transfer payment (BSP). The key is the lack of fungibility. By allocating different monies into different accounts, no one pound is (necessarily) the same as any other, which is why the government could label the Winter Fuel Allowance thus and expect that money to be spent disproportionately on this rather than, say, alcohol. If the money is not used for *winter* fuel, it is more likely to be used for something similar (rival account). This would then mean the mental account for fuel is integrated (Case 1) to offset loss aversion. Net benefit from fuel consumption is made up of the utility of consumption *v(C)*, government transfer *t* (WFA) and the disutility of expenditure *E(C)*. Cases and Diagrams 1 and 2 show the cases where the WFA is larger than fuel expenditure (Rule 3) and vice versa (Rule 4) respectively.

Case 1: $v(C)+E(t-C)$ if mental account integrated
Case 2: $v(C)-E(C)+T(t)$ if mental account segregated

Remember under a Hicksian framework, we would always segregate. Figure 2 shows two cases: where loss aversion is particularly low (nearing Hicksian conditions) and where it is especially high. We can see segregation is clearly preferred in the former case, whereas in the latter, the individual's pain of paying for fuel is so great, the gain can do little to attenuate it. If we assume this pain is inversely related to income, we can surmise pensioners, who tend to be relatively poorer, are more likely to follow (2*). Additionally, people aged 60 and over spend around £535 on average on fuel every year. Say half of this is in winter. [13] Then on average, *E(C)>t*. In both cases, we would not expect WFA monies to be integrated into a fuel account, enabling us to reject the null hypothesis of mental accounting versus the alternative of Hicksian demand properties. Thus there is no economic rationale to having a separate government transfer entitled WFA. On the other hand, if *t* was sufficiently large, recipients would integrate and ε would then be higher than 0.28.

[12] Thaler (1985), p. 202.
[13] The British Household Panel Survey (BHPS) shows average pensioner income as £22,500, while for the general population it is £31,942, nearly £8,400 lower. Average fuel expenditure of £510 (Expenditure and Food Survey, EFS) to £563 (BHPS).

Figure 1: Mental account for fuel is integrated (*t* is large relative to *c*)

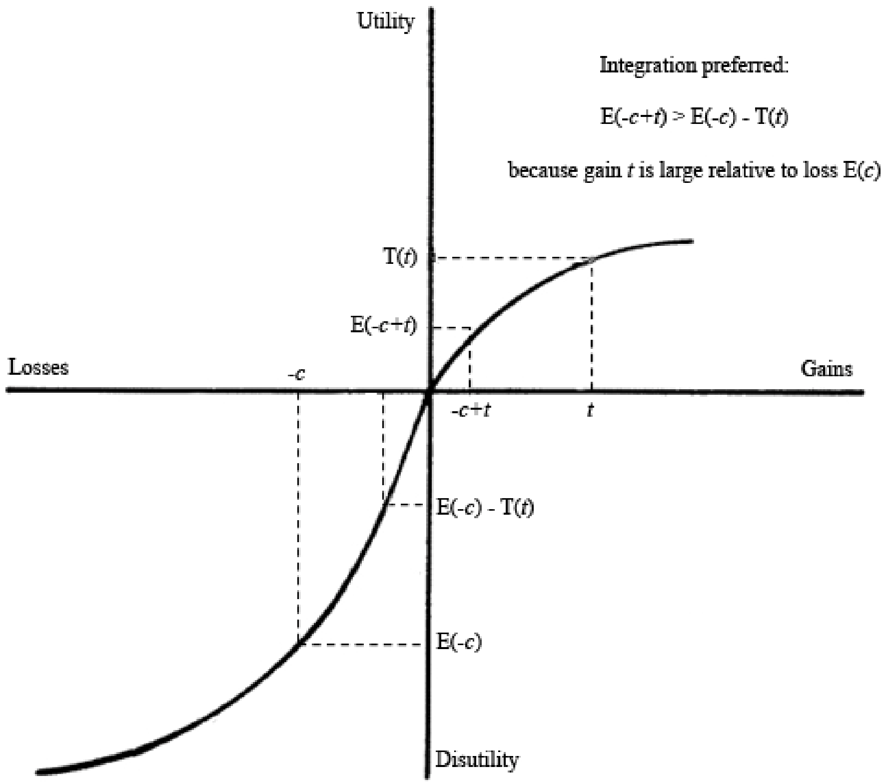
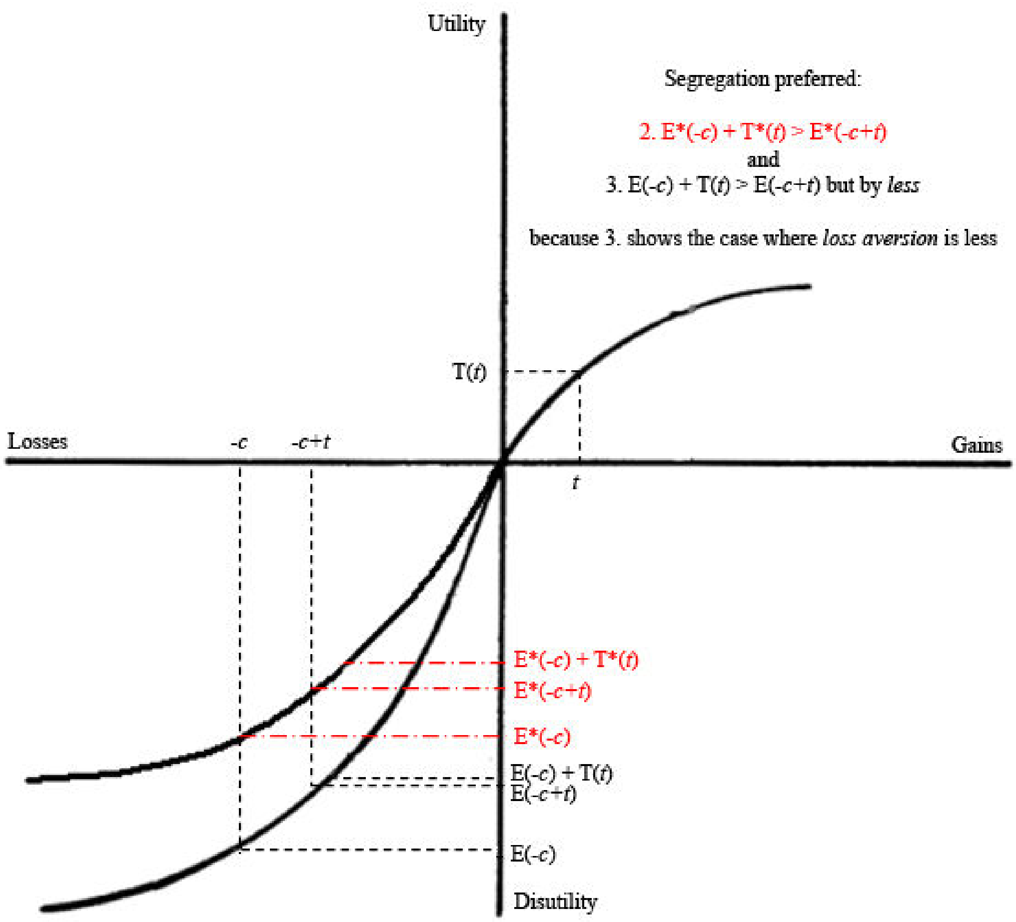


Figure 2: Mental account for fuel is segregated (*t* is small relative to *c*)



But some budgets are set too low to help deal with "self -help problems."[14] Consumers want to consume a *small* amount of a good, but self-control problems prevent them from not consuming far more (especially for luxury goods). Heath and Soll (1996) agree, saying mental accounts cause people to underconsume. Existing mental accounting theory suggests pensioner fuel underconsumption (characterised by excess winter deaths) is because pensioners recognise high fuel costs, and hence label it mentally as a luxury. Thaler (1985) suggests that "the gift of a small portion" would solve this problem by removing the guilt of consumption. Clearly, this argument lacks satisfying theoretical or empirical impetus in our case in public economics.

Munro (2005) is the only paper that specifically deals with the WFA, although Walker *et al.*'s (2004) look at Child Benefit (CB) surprisingly finds the marginal propensity to spend CB on children is zero while the marginal propensity to spend it on alcohol may be as high as 0.6, although not because parents don't care for their children. Their interpretation is that parents care so much for their children, they insulate them from all risk – parents spend enough on their children before they receive the benefit. When the parents receive it, they decide to replace the expenditure they had refrained from before. Both estimate Engel curves analysing how the share of income spent on fuel and children changes due to the WFA and CB respectively.[15] Engel curves show demand for one good as a function of income, with all prices held constant.

In this way, Munro's paper is a value-added extension. He discusses the Prelec and Loewenstein (1998) theory without delving into empirics, although he does find significant evidence in favour of mental accounting. For a household of income £3000, the effect of the Allowance is to consume approximately £17.30 more fuel a year, or around 8.65 percent of the current £200 payment. Increasing the income to £8000, this effect falls to £11.60, but is still above the 90 pence increase that would result from an ordinary increase of £200 in the BSP.

Whether the actual positive effect of labelling is this high may be down to misspecification. The use of his dummy "for Winter Fuel payment … [of] £100 or more"[16] is, upon first sight, a good specification, but ignores the impact of the *level* of WFA, particularly relative to income.[17] Also, consider that only those 60 or older from 1999 received a sufficiently high level of WFA to be included in the test group. The control group should only be those *not* receiving the Allowance, however because he ignores those who received £20 or £50 in preceding years, the control group includes many who *do*. The interpretation of the variable is therefore ambiguous.

He uses the council tax band to act as a proxy for house size in a period when house prices increased by 92 percent unequally across the country.[18] He does not control for each region, instead only for Scotland, even though data shows there were two English regions that had an excess winter death count due to the cold higher than that of Scotland.[19] A temperature variable would have been useful here – clearly heating consumption is greater in colder temperatures. Healy's (2003) study into factors explaining this phenomenon across Europe found

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[14] Thaler (1999), p.221.
[15] One qualification to make here is that Munro's paper is preliminary and not yet complete.
[16] Munro (2005), p. 21.
[17] This is something especially important in 2003-04 when pensioners over 80 (who are often the poorest) got an extra £100.
[18] Council of Mortgage Lenders, quoted in "Brown moves to cool house prices."
[19] ONS, quoted in "UK and Irish older people most at risk from cold weather."

the most important determinant to be *variations* in mean winter temperature. Seasonal variation in mortality was highest amongst (generally warmer) southern European countries; but elsewhere, Northern Ireland and Britain were highest. This could be due to a lack of protection indoors from the cold, as well as income poverty. The first factor makes intuitive sense for a country like Portugal, where house-building best complements its warm weather. Wilkinson *et al.* (2004) find "the risk of winter death seems to be widely distributed in elderly people," or that income isn't an important determinant of excess fuel deaths, but that women and those with respiratory diseases are more likely to die.

Accurate specification for an Engel curve is important too, either to accurately model consumer responses to policy reforms; our work on the changes in relative demand for fuel; or in estimating the impact of demographic change and equivalence scales. Munro uses a squared income specification for the Engel curve, which fits the data well for British Household Panel Survey (BHPS) households. Blundell *et al.*'s (1998) Family Expenditure Survey (FES) semiparametric estimation of consumer demand however cannot conclusively say whether a linear or quadratic functional form would be more suitable for fuel expenditure. They truncate their data very parsimoniously, cutting merely the top and bottom 2.5 percent of incomes, causing their simple relationship to break down for rich people.[20]

SECTION B: THEORY: PAYMENT METHODS

By using transaction-specific accounts, consumers first debit the account by the amount paid for the item, and later credit the account by the benefit they get from using the item. This accounting relation is used by Prelec and Loewenstein to understand how recipients pay for expenditures. When an individual makes a purchase, he experiences an immediate pain of paying, which can undermine pleasure derived from consumption. They propose a theory of prospective accounting which argues if a product has already been paid for, then individuals do not have thoughts of payment when consuming and can therefore enjoy the product more: "the pain associated with payments prior to consumption is buffered by the thoughts of the benefits that the payments will finance. Another important concept is coupling, which refers to the degree to which consumptions calls to mind thoughts of payment and vice versa."[21]

A WFA recipient would have the decision criteria of whether to consume an extra unit of fuel as:

$$\delta \sum_{b \geq 1}^{B} U_b - \lambda \delta \sum_{c \geq 1}^{B} p_c > 0 \qquad (3)$$

where U_b *= utility from the all future benefits at time b of consuming a unit of fuel now (e.g. being warm now and not getting ill tomorrow)*

p_c *= the disutility from all future costs of payment for a unit of fuel now*

δ *= discount rate by which future benefits and costs are discounted*

λ *= Lagrange multiplier; marginal utility of money when consumer optimises*

[20] Blundell et al. (1998), Figure 2: Fuel Engel curves, p. 440.
[21] Prelec and Loewenstein (1998), p. 4.

Prelec and Loewenstein distinguish between different types of (dis)utility, in the form of the 'consumption experience' and 'payment experience.' To avoid their complex algebraic route, we simplify here. (3) expands to:

$$\delta\sum_{b\geq 1}^{B}(U_b + U_c) - \lambda\delta\sum_{c\geq 1}^{B}(p_b + p_c) > 0 \quad (4)$$

U_b = utility drawn from the consumption e.g. the house getting warmer.
U_c = utility drawn from making the payment e.g. relief the future debt has been paid.
p_b = cost of sacrificing future consumption; opportunity cost.
p_c = the pain of payment, of actually handing the hard-earned money over.

As should be obvious, these terms are endogenous – for example there is a trade-off between consumption now and in the future:

$$p_b = \alpha\left(\frac{U_b}{\sum_{t>b}^{T} U_t}\right)\sum_{t>b}^{T} p_t \quad (5); \qquad U_c = \beta\left(\frac{p_c}{\sum_{t>b}^{T} p_t}\right)\sum_{t>b}^{T} U_t \quad (6)$$

where α = degree to which payments temper the pleasure of consumption ("tempering")
β = the degree to which consumption buffers the pain of payment ("buffering")

The above relations show Prelec and Loewenstein's imputation of these non-linear linkages between the four terms in (4). For example, "p_b is now the imputed cost of consumption at time *b* and is the sum of payments still due at *b*, $\sum_{t>b}^{T} p_t$, prorated over future consumptions still remaining, $\sum_{t>b}^{T} U_t$ adjusted for the degree of coupling, α ."[22] Someone with a low price elasticity of demand for fuel would have a low α , while individuals who are employed and therefore stay out of the house most of the day, would not derive much pleasure out of keeping the heating on during the day and would have a low β . Substituting these into (4), we get a prediction of how consumption and payment are actually experienced by pensioners:

$$\delta\sum_{b\geq 1}^{B}\left[U_b + \beta\left(\frac{p_c}{\sum_{t>b}^{T} p_t}\right)\sum_{t>b}^{T} U_t\right] - \lambda\delta\sum_{c\geq 1}^{B}\left[\alpha\left(\frac{U_b}{\sum_{t>b}^{T} U_t}\right)\sum_{t>b}^{T} p_t + p_c\right] \quad (7)$$

When deciding upon how to pay for fuel bills, the consumer would try to maximise the above term. Hedonic efficiency (consumers want to enjoy the good rather than have nagging thoughts of payment diminish enjoyment) and decision efficiency (knowing what the price of each unit is, so that informed decisions over consumption can be made) are key to maximising utility. *Needing* to know the costs, yet not *wanting* to means there is a trade-off between both. Therefore a one-off payment, in November when temperatures start getting colder, could help

[22] Prelec and Loewenstein (1998), p. 11.

decouple the consumption-payment relationship and improve hedonic efficiency, thereby increasing fuel expenditure.

	Method of payment	Description
Prepayment	Slot meter	Similar payment to mobile phone. Top-ups purchased ex-ante and inserted into meter. Strong coupling.
	Gas/ Electricity card	Similar to slot meter.
	Budgeting scheme	Fixed monthly direct debit is paid of pre-agreed amount, with any under-/overpayment resolved only at the end of the year. Strong decoupling.
Postpayment	Account	Quarterly bills. Some degree of coupling.
	DSS pays whole bill	For poorest households. Strong decoupling.

Table 2: Methods of payment for fuel

Consider the payment options for fuel bills in Table 2: pre-payment and post-payment. Post-payment promotes decision efficiency because the consumer consciously thinks about his future bill (p_c), and can therefore better control "self-help problems."[23] Prelec and Loewenstein say pre-payment encourages hedonic efficiency because thoughts of payment at the time of consumption are neglected. Consider an avid internet surfer paying fixed fees for internet access: U_c is high because he can surf to his heart's content, safe in the knowledge he won't have to worry about the ticking meter. Cheema and Soman (2006) show controlling spending also depends on how "malleable" different accounts are, which follows on from our earlier fungibility discussion. Say an individual is, at the end of a month of heavy partying, agonising about whether to go for an expensive dinner with friends. His 'entertainment' account is in significant deficit. By simply redefining the dinner as part of his 'food' budget, not 'entertainment', he may justify the spending more easily to himself. Cheema and Soman say creating clear definitions of their spending categories is essential in decision efficiency.

We show how consumers choose their method of payment (from (4) and (5)):

$$\text{Present Value (Prepayment)} = \delta\sum_{b\geq 1}^{B}\left(U_b + 0\right) - \lambda\delta\sum_{c\geq 1}^{B}\left(\alpha p_b + p_c\right) \quad (8)$$

$$\text{Present Value (Postpayment)} = \delta\sum_{b\geq 1}^{B}\left(U_b + \beta U_c\right) - \lambda\delta\sum_{c\geq 1}^{B}\left(0 + p_c\right) \quad (9)$$

With prepayment, there is no utility derived from paying in advance ($U_c=0$) but the payment would reduce the pleasure from consumption initially. With postpayment, the pain of payment is buffered by consumption because the foregone interest due to early payment is saved ($p_b=0$). Instead it preys on debt-averse individuals' minds throughout consumption that the payment is still to come. Prepayment will be preferred if:

$$\delta\sum_{b\geq 1}^{B}\left(U_b + 0\right) - \lambda\delta\sum_{c\geq 1}^{B}\left(\alpha p_b + p_c\right) > \delta\sum_{b\geq 1}^{B}\left(U_b + \beta U_c\right) - \lambda\delta\sum_{c\geq 1}^{B}\left(0 + p_c\right)$$

[23] Usually, if a household runs up arrears with a utility they would risk having their fuel supply disconnected until they paid the amounts owed. But the advent of prepayment slot meters have enabled greater coupling between consumptions and disconnection, dramatically reducing rates of disconnection.

$$\Rightarrow -\lambda\delta\sum_{c\geq 1}^{B}(\alpha p_b) > \delta\sum_{b\geq 1}^{B}(\beta U_c)$$

$$\Rightarrow \delta\beta\sum_{b\geq 1}^{B}(U_c) + \lambda\delta\alpha\sum_{c\geq 1}^{B}(p_b) > 0 \tag{10}$$

We can now treat this as the condition for whether coupling is preferred, rather than if prepayment is preferred. This is because we have departed sufficiently from Prelec and Loewenstein's original theory, where prepayment strictly maximised hedonic, and postpayment decision, efficiency. Prelec and Loewenstein hinted at the trade-off shown in Table 2 whereby there are prepayment methods that maximise hedonic (budgeting) as the theory predicts, but also prepayment options which maintain a strong coupling (slot meters, cards). Through (10), we can explicitly see poor households look to achieve the optimal trade-off between hedonic and decision efficiency, whereas rich households emphasise maximising the former.

This is likely if:

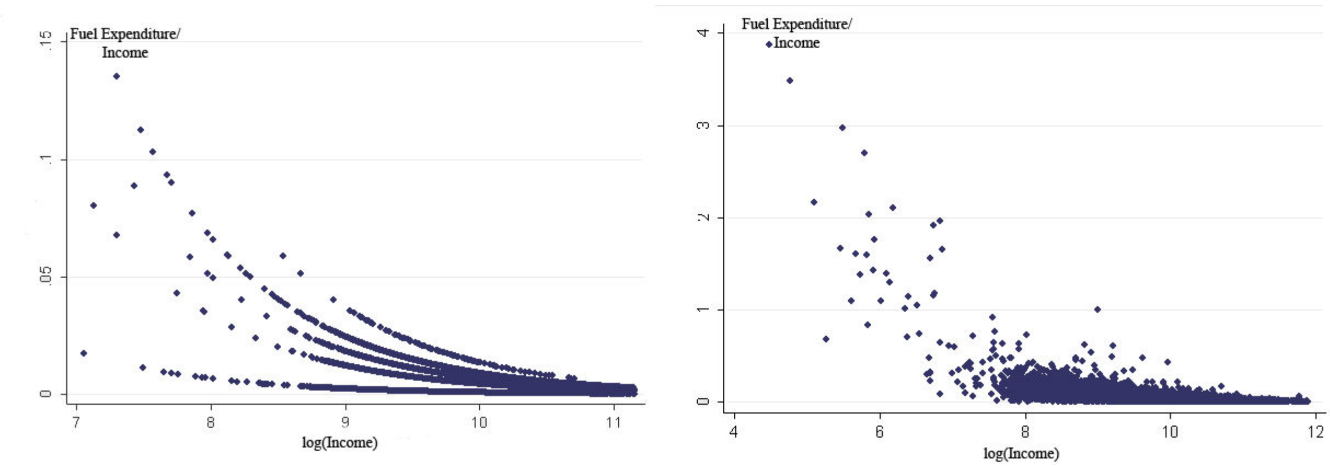
1. λ is high i.e. the individual is poor because he cares a lot for each additional pound – remember our discussion in Figure 2.
2. α is high i.e. coupling is high and individual is poor. Tempering is greater when you are poor because it is harder to part with the money. Alternatively, "tightwads are less likely to decouple payments and consumptions."[24]
3. β is high i.e. consumption is viewed as "utilitarian"/ "relatively virtuous."[25]
4. δ is high i.e. individual is patient. This is unlikely – a 60 year-old would typically be less worried about saving for the future than a 40 year-old. When considering paying for a product, consumers are debt-averse so they would prefer to repay bills as quickly as possible. But, as Prelec and Loewenstein show, they display a hyperbolic discounting function, which creates an incentive to constantly postpone painful payments, such as clearing bills.[26] In this case, they would prefer postpayment.

SECTION C: THE EVIDENCE

We look at both BHPS (1997-2003) and EFS (2001-2003) data to analyse mental accounting empirically.[27] The EFS has the advantage of recording the method of payment for fuel, but is a cross-section, whereas the BHPS is more robust because it is a panel. Using similar controls, we compute the 'WFA effect' across both, and additionally the effect of payment methods with the EFS, but since one uses random effects models and the other OLS, some results do vary. As Munro illustrates, take-up rates of WFA are very high and it

[24] Kivetz (1999), p. 253.
[25] Kivetz (1999), p. 263.
[26] The "ignoring the problem and hoping it goes away" syndrome.
[27] Before this time, the EFS was two surveys separately and therefore carried less information for our purposes. The 2001 EFS did ask questions on the Winter Fuel Allowance, although this was only for one year.

is reasonable to assume a 100 percent take-up in the following analysis, since neither survey asks explicitly asks upon the receipt of the Allowance.

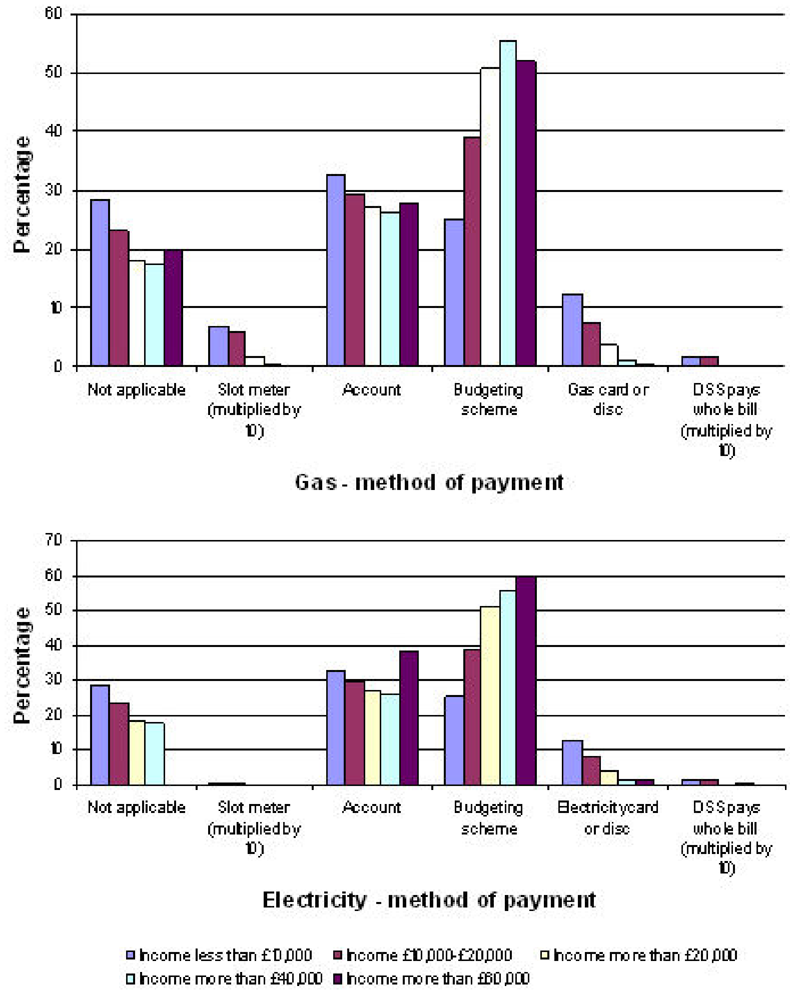


Source: British Household Panel Survey (1997-2003) **Source:** Expenditure and Food Survey (2001-2003)

Figure 2: Yearly expenditure on fuel as a proportion of income (1997-2003)

After trimming households with reasonable assumptions about especially income and expenditure for most of the following regressions, we have an unbalanced panel of 22,107 observations and 3,778 households, of which we have 1,604 pensioner households for the BHPS, while for the EFS, we have 20,047 and 6,579 respectively. For both datasets, we exclude households whose rent includes heating and lighting bills and those reporting fuel expenditure over 30 percent of income. In Figure 2, a *[log(income)]*^{2} term for the EFS is unclear, suggesting heteroscedasticity issues which further research may wish to explore. For the BHPS, amazingly, there are five distinct Engel curves, suggesting households have five different sets of demand preferences. Blundell *et al.* find a relation similar to 3b, but not such a flawless relation as 3a perhaps as they do not use panel data. I could not disaggregate the different curves, and possibly our analysis could suffer from an inaccurately macro-aggregated Engel curve.

Figure 3 confirms our predictions at the end of Section B. A budgeting scheme is most popular amongst wealthier households, because it reduces coupling and the benefit of consumption is less tempered by the pain of payment. Therefore λ and α are low and inequality (10) is less likely to be fulfilled. Even though prepayment meters charge a higher tariff than for post-payment alternatives, poorer households prefer this method. Paying by DD (account or budgeting) is usually ten percent cheaper than paying by cash/cheque and more so compared to prepayment. In a Scottish Executive survey, 22 of a sample of 40 households who had switched their method of payment for electricity said it was to increase convenience and ease of payment, implying they were looking to reduce the pain of paying p_c.



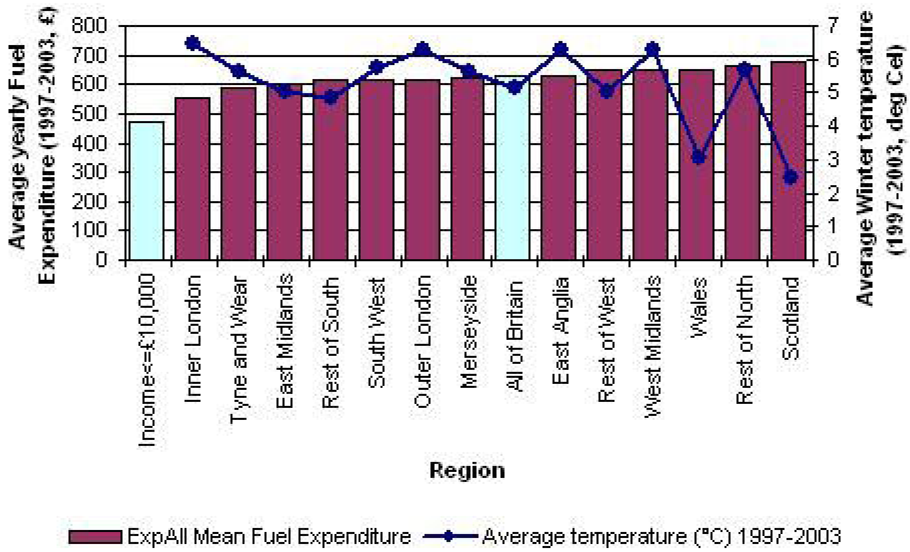
Note: 'Not applicable' suggests households do not consume that type of fuel.
Source: Expenditure and Food Survey (2001-03)

Figure 3: Weekly fuel expenditure by method of payment for Gas and Electricity Central Heating

Figure 4 shows that the traditionally cold areas of the country, such as Scotland spent more on fuel than the rest of the country.[28] The poorest households spend the least, while the temperature is higher in congested areas such as London. Using trend average monthly days of frost instead of temperature also provides similar results.[29] There is a correlation between fuel expenditure and temperature of -0.54 and of 0.24 between expenditure and frost.

[28] Interestingly, fuel underconsumption is lowest in Scotland also because it has the lowest incidence of excess winter deaths (16 percent), whereas England, comparatively richer, has a level of 19 percent (Healy (2003), p. 785).

[29] One qualification for the correlation between the two not being stronger is that the way regions are defined by the Met Office and BHPS are different. Temperature was calculated through imputation of 35 regional weather stations around England, which were not spread equally across the country (Scotland and Wales were treated as individual regions, so using already imputed values). As a result, computing for example in East Anglia temperature, an arithmetic mean of Lowestoft on the coast and Cambridge further inland would not give (necessarily) the best indication of actual trend temperature since the coast would be a lot colder than inland. Despite this, the variable seems to perform well.



Source: British Household Panel survey (1997-2003), Met Office

Figure 4: Average trend temperature 1971-2004 and yearly fuel expenditure by region

SECTION C1: THE EVIDENCE: BHPS

We test for the 'WFA effect' in two ways: looking at factors affecting the amount of fuel expenditure, and Engel curves with income shares of fuel. (11) uses Munro's Winter dummy as discussed above. (12) more robustly allows these coefficients to explicitly differ and derives from a Piglog or Almost Ideal Demand System (AIDS) specification like Blundell *et al.* and forms the basis of proceeding analysis, where the β_{WFA} determines the effect of the WFA. Notice the coefficients on the components of *Income* are 1 and β_{WFA} respectively. If money was fungible and we were to reject the null of mental accounting, both coefficients would be equal. Piglog neatly circumvents the aggregation problem suggested in Figure 2a of translating five societal preference relations into one macro Engel curve by allowing consistent non-linear aggregation through its assumptions of additivity, homotheticity and symmetry. Equation C goes one step further, forming a quadratic AIDS model.[30]

$$\log(FuelExpenditure) = \beta_0 + \beta_1 \log(Income) + \beta_2 \log(Income)^2 + \beta_3 Winter \qquad (11)$$

[30] We do not derive the appropriate Engel curves from microfoundations because of space constraints. The interested reader is referred to Deaton and Muellbauer (1980) pp. 17-20, 61-76; Pollak and Wales (1992), pp. 22-71; Varian (1992), pp.209-14.

$$w = -\beta_1 \log(Income) + other$$
$$\Rightarrow -\beta_1 \log(Income) = \beta_1 \log(y + \beta_{WFA} WFA)$$
$$\Rightarrow -\beta_1 \log\left[Income\left(\frac{y + \beta_{WFA} WFA}{Income}\right)\right]$$
$$\Rightarrow -\beta_1 \log Income + \beta_1 \log\left(\frac{y + \beta_{WFA} WFA}{Income}\right)$$
$$\Rightarrow -\beta_1 \log Income + \beta_1 \log\left(\frac{y}{Income} + \frac{\beta_{WFA} WFA}{Income}\right) \approx -\beta_1 \log Income + \beta_1 \log\left(1 + \frac{\beta_{WFA} WFA}{Income}\right)$$
$$[\log(1+x) \approx 1 + x]$$
$$\Rightarrow -\beta_1 \log Income + \beta_{WFA} \beta_1 . \left(\frac{WFA}{Income}\right) = -\beta_1 \log Income + \beta_2 \left(\frac{WFA}{Income}\right) \qquad (12)$$

where w = Fuel expenditure/ Total income
WFA = Winter Fuel Allowance amount/ Total income
y = 1-WFA

	Equation A:			Equation B:			Equation C:		
Dependent Variable	**log(Fuel Expenditure)**			**Fuel Expenditure/ Income ***			**Fuel Expenditure/ Income ***		
	Coef.	**Std. Err.**	**t-stat**	**Coef.**	**Std. Err.**	**t-stat**	**Coef.**	**Std. Err.**	**t-stat**
log(Income)	0.2864	0.0705	4.06	-3.3031	0.0966	-34.2	-36.4881	1.4395	-25.4
$[\log(Income)]^2$	-0.0125	0.0036	-3.48	-	-	-	1.7106	0.0741	23.1
WFA/Income	-	-	-	0.5326	0.0676	7.88	0.1290	0.0664	1.94
Winter	2.4907	1.1163	2.23	-	-	-	-	-	-
Winter*log(Income)	-0.4853	0.2241	-2.17	-	-	-	-	-	-
Winter*$[\log(Income)]^2$	0.0236	0.0112	2.1	-	-	-	-	-	-
Constant	3.8276	0.3508	10.91	32.3108	0.9646	33.5	193.3392	7.0307	27.5
Hausmann test (χ^2)	148.5			110.55			99.13		
No of observations	22160			4726			4726		
Overall R^2	0.3284			0.4407			0.4886		

* Multiplied by 100.
Income over £50,000 and under £2000, fuel expenditure under £5,000, rooms over ten and households with more than nine people have been excluded. For a full table of variables, including controls, see Appendix 3. Regressions shown are random effects models.
Source: British Household Panel Survey (1997-2003)

Table 3: Regressions showing effect of Winter Fuel Allowance on Fuel Expenditure

Income and expenditure are both deflated by national RPI.[31] The WFA is left in nominal terms since the payment is so small, deflating would not affect our results. Appendix 2 gives all variable definitions. ε in Equation A is similar to Munro's estimate, suggesting fuel expenditure is price inelastic. From B, we see our results follow Engel's Law, that the proportion of total expenditure devoted to a good declines as income rises, as *w* falls by 3.3 percent when income goes up by one percent. Furthermore, we can calculate β_{WFA} as 0.53/3.3=0.16. This is highly significant and is evidence against mental accounting. The interpretation is that £1 of other income (*y*) is worth the same as 16p of WFA to an individual receiving the Allowance. In other words, raising the WFA by £6.20 is the same as raising the BSP by £1 in terms of impact upon fuel expenditure, notwithstanding the ten

[31] As opposed to regional RPI - because there is very little difference between regional rates of inflation.

percent running costs of the Allowance we assumed at the start. This suggests individuals do not actually respond to labelling by integrating those monies into the fuel account. Instead, they spend the majority of it elsewhere and segregation is distinctly preferred. To confirm this:

$$H_0 : \beta_{WFA} = 1 \Rightarrow {(\beta_2)}/{\beta_1} = 1 \Rightarrow H_0 : \beta_2 - \beta_1 = 0$$

$$H_1 : \beta_{WFA} \neq 1$$

$$t = \frac{\beta_2 - \beta_1}{\sqrt{\sigma^2_{\beta_1} + \sigma^2_{\beta_2} - 2\,\mathrm{cov}(\beta_1, \beta_2)}} = \frac{0.533 + 3.3}{\sqrt{0.0676^2 + 0.0966^2 - 2(-0.4812)(0.0676)(0.0966)}} = 26.9 \therefore \text{reject } H_0$$

Equation C shows similar results, but because of the *log(income)*^{2} term, the determining β_{WFA} is non-trivial. Both results are left in for comparison: B offers an easier interpretation for the relevant coefficient; C is the specification recommended by Figure 2 but offers few further insights. Equation A conversely suggests a positive effect of the Allowance for the lowest income decile that rapidly disappears – a household on income £3000 would expect fuel expenditure to increase by 4.46 percent if the extra money was the WFA, 2.14 percent otherwise. But for income £8000, this drops to 2.45 and 2.42 percent instead, far less than Munro predicts.

We know generally $t<c$ i.e. Case 2 applies. Removing the restrictions placed above β_{WFA} is still below one, increasing to 0.43. Testing Equation B just for those households where $t>c$ (where it would be more likely to accept the null of mental accounting), β_2 is 1.41 and β_{WFA} 0.4, implying mental accounting does not hold in either case. However, we cannot conclusively say Case 1 is refuted because these results should be treated with caution – placing such a restriction removes half of the sample in B, while these are likely to be smaller households with employed house members, who are home less and therefore require heating less. The other coefficients stay broadly similar, although the temperature variable is significant and more pronounced, indicating 1°C above trend decreases fuel expenditure by an unlikely 11 percent.[32]

Also significant are number of rooms and house members. Both are quadratic, with each additional room/ member adding less to the fuel bill than the last. Only having a detached house adds 6-8 percent to fuel bills as a proportion of income compared to a terraced in our specification, thus leaving neither semi-detached or flats as significant effects. Types of fuel not as prevalent around the country such as oil and solid fuel increase bills substantially, as does region. Most region variables are not significant in determining share of income spent on fuel, although living in Scotland adds around 6.5 percent relative to London, while in A, regions matter greatly with Scottish residence adding 20 percent to bills. This makes sense: people spend more in absolute terms across different regions, but mean incomes also vary, meaning the *w* variable is not as affected by region. Wilkinson *et al.* too show living in West Scotland increases chances of winter death by 14 percent. The BHPS (and EFS) regions are recoded to reflect the regions in this paper, to simplify comparisons between both works. Living in

[32] Removing all our above restrictions to test the entire sample for robustness increases the explanatory power of the model (. Time effects become more pronounced, although β_{WFA} is broadly similar.

Scotland adds nearly 20 percent to bills in Equation A, while conversely in Wales, the second greatest amount is spent on fuel, and yet their incidence of excess winter deaths is the second lowest.

As Munro, we also include dummies for the month interviews are conducted. 86 percent of interviewees are asked during September and October and both exhibit a considerably lower fuel expenditure reported than other months, reflecting they are myopic and remember recent transactions better than older ones. The same phenomenon applies to income, so deflating by income in B and C makes the effect disappear.

The temperature variable is defined as average temperature minus trend winter temperature over 30 years and is derived from Met Office data from 35 weather stations. We find 1°C of unseasonably high temperature reduces *w* by around one percent. The real effect may be greater; instead the possible computational errors mentioned above may have introduced a high standard error and downward bias in the value of the coefficient. It performs better though than *min(0, average-trend)* or *max(0, average days of daily frost-trend)*.

The 'accommodation problems' variables for leaky roof, damp walls, rot all have powerful implications for policymaking, even though the *w* specification withdraws explanatory power from them. They are jointly highly significant only in A, which is likely since the problems are indicative of general state of housing and income too. From a policy perspective, the data shows these problems add around eight percent to bills. Clearly then, tackling these problems in the home[33] would save a lot in fuel. The average person suffering from *all* these problems spends £736 on fuel a year (0.6 percent of BHPS dataset), compared to £626 for others. Each would save £59 a year if these problems were tackled. Extrapolating for an estimated 15 million households in Britain this would be a saving of £5.3 million a year.[34] Table 4 provides further details, but since health is self-reported and qualitative, we cannot read too much into its insignificant in our regressions. Schemes that help fuel poor households with loft insulation etc. are more effective in tackling fuel underconsumption than free WFA cash because a) their effects are permanent; and b) they do not suffer from Cheema and Soman's malleability problem. The advantage of food/education vouchers in the USA is they *force* the recipient to integrate with the relevant account and consumption increases to an efficient level.

Accommodation problem	Yearly fuel expenditure (£)	Percentage of people with 'good health'	Percentage of people with 'poor health'	Observations
Condensation	601.02	**74.95**	**13.33**	2790
Leaky roof	**722.95**	78.08	11.15	780
Damp walls, floors etc.	653.11	75.50	11.72	1612
Rot in windows, doors	646.30	75.56	12.59	1747
Average across population	625.82	78.44	10.34	22482

'Good health' defined as 'excellent', 'good', 'fair'; 'Poor health' defined as 'poor' ,'very poor'
Source: British Household Panel survey (1997-2003), Met Office

Table 4: Accommodation problems and their effects on fuel expenditure and health

[33] See Footnote 8.
[34] Clearly, this is a very high-level analysis, and should be treated as such.

SECTION C2: THE EVIDENCE: EFS

In formulating a similar regression with the EFS, we also add variables for 'type of payment' to test the prepayment theory. Notice F is quadratic in income, as in Figure 2, without taking away explanatory power from the *log(income)* term as is the case with Blundell *et al.*'s FES work. This may be due their parsimonious trimming, whereas here we consider only those individuals with $w<0.3$.[35]

	Equation D			Equation E			Equation F		
Dependent Variable	**log(Fuel Expenditure)**			**Fuel Expenditure/ Income**			**Fuel Expenditure/ Income**		
	Coef.	**Std. Err.**	**t-stat**	**Coef.**	**Std. Err.**	**t-stat**	**Coef.**	**Std. Err.**	**t-stat**
log(Income)	0.0457	0.0084	5.42	-0.7682	0.0198	-38.9	-3.9871	0.1256	-31.7
log(Income)2				-	-	-	0.3054	0.0118	25.94
WFA/Income				1.3185	0.0329	40.02	1.2900	0.0324	39.82
Slot	-	-	-	-0.0559	0.0246	-2.08	-0.0463	0.0265	-1.75
Budget	-	-	-	-0.0471	0.0246	-1.91	-0.0559	0.0242	-2.31
Card	-	-	-	-0.2225	0.0294	-7.57	-0.1886	0.0289	-6.52
Gas - Slot	0.1120	0.0636	1.76	-	-	-	-	-	-
Gas - Budget	0.0865	0.0121	7.12	-	-	-	-	-	-
Gas - Card	0.1005	0.0190	5.29	-	-	-	-	-	-
Electricity - Slot	-0.0549	0.0430	-1.28	-	-	-	-	-	-
Electricity - Budget	0.0478	0.0112	4.25	-	-	-	-	-	-
Electricity - Card	-0.0056	0.0152	-0.37	-	-	-	-	-	-
Number of observations	18914			18914			18914		
Number of variables	38			35			36		
F-Test	160.11			307.46			328.24		
Adjusted R^2	0.2422			0.3619			0.3838		

For a full table of variables, including controls, see Appendix 3.
Control for payment methods is Payment by Account for all equations.
All standard errors are Huber/White/sandwich estimators of variance to attempt to counter heteroscedasticity.
Source: Expenditure and Food Survey (2001-2003)

Table 5: Regressions showing effect of different payment types

The results should show decision efficiency is promoted by having slot meters or cards, thereby reducing expenditure on fuel. However, we see gas expenditure is 11 percent higher for slot users compared to account holders, while for electricity users this effect is less pronounced (however both are insignificant). If true, this could be because the greater per-unit expense for this method outweighs the gain in decision efficiency. Remember in (10) we ignored price differences, assuming they were constant. E and F offer results more consistent with theory. The most pronounced effect is of gas cards – 22 percent less is spent as a proportion of income. On the other hand, budget customers, buoyed by cheaper bills, spend between 5-9 percent more on bills. This is evidence that α, measuring coupling is low while λ is high i.e. the budget customers prefer to maximise hedonic efficiency because they are richer and therefore the price pressures are not as acute, something Figure 3

[35] As with the BHPS, testing the same regressions without these restrictions provides very similar results.

confirms. The former result is likely to exacerbate over time as gas prices rise at a record pace. Because of these cyclical effects we can still assert Prelec and Loewenstein's theory holds in practice.

We also consider WFA/ Income again. The results approach Munro's results, with $\beta^{E}_{WFA} = 1.87$, providing evidence *for* mental accounting. The reason may be that in the panel, I controlled for individual heterogeneity, whereas for a cross-sectional study this is not possible. Following expenditure behaviours over time is important here since the WFA has only recently become important government expenditure.[36]

The coefficients on the rooms and type of house variables corroborate with the BHPS results, although living in a flat seems to lower fuel bills by a larger 15 percent. This effect disappears when determining *w* because flat inhabitants are generally poorer households that would also have a correspondingly lower income. An additional adult in the house adds more to heating bills than an additional child. The employment variables are interesting: if there is someone employed in the house, they would spend more time out of the house and would therefore require less heating; however if the head of household is unemployed, the income effect reduces expenditure by five percent, while expenditure as a proportion of income is cut by even more. Myopic interviewees interviewed in the first two quarters report a fuel expenditure of 10-12 percent more than if they are asked in the fourth quarter, which is what we expected earlier, while the regional dummies are highly significant, as with Equation A.

SECTION D: CONCLUSIONS AND EXTENSIONS

This paper finds strong evidence for Prelec and Loewenstein's theory on preferences for prepayment. Further research could attempt to quantify the (dis-)utilities shown there, as well as incorporate the price effect that distorted more precise conclusions from our analysis. This factor will be significant in the near future as energy prices increase. The FES 2000 and the EFS 2004 ask WFA-specific questions which cast doubt upon our assumption of 100 percent take-up. Due to the absence of this information in our data, we have not considered the implication of backdated WFA payments (these may mean $t>c$ in more cases), which appear to be slow to materialise. Better computation of the temperature and health variables would be desirable. A comparison with similar government transfers in a mental accounting framework would make the results more robust e.g. cash help towards childcare provision, or German *Kindergeld*. A major research could be to separate the different Engel curves in Figure 2a, determining which types of households correspond to which demand preferences. This could potentially be invaluable in determining which sections of society transfers such as the WFA should be aimed at the most.

We have gained a preliminary insight into public economics mental accounting. The WFA does not seem to have an effect on fuel expenditure. The timing of the payment could have affected our result – if recipients view it as a Christmas windfall, they could put a disproportionate amount into their 'entertainment' or 'presents'

[36] A more minor point: the sample years 2002-2004 were when the WFA was the same level. Therefore there is less variation than in the panel. Therefore cross-sectional analysis may provide biased results.

accounts instead of 'fuel'. This is again a topic for further research. As this study and Walker *et al.*'s have shown, free cash, however labelled, does not produce the desired results. Currently, the WFA is viewed as free cash, fit to spend freely. Integration is only preferred (Case 1) if the WFA gain is *larger* than the fuel expenditure. Instead expenditure is more than three times the Allowance level, so this paper cannot give a clear-cut rejection of the null of mental accounting, simply saying the conditions are not right to be able to test the magnitude. Testing this places too severe restrictions on the data.

If the government does not raise the WFA level substantially (as would seem) to counter the energy price increases and this issue, it would be far more cost-effective to provide pensioners the payment through a simple increase in the BSP. If the goal is still to tackle fuel underconsumption, there ought to be a restriction placed on the WFA, whereby it cannot be used for anything other than fuel. This 'voucher' could then be distributed just in time for winter. Alternatively, this money could be used to target only fuel poor, vulnerable households to eradicate problems such as leaky roofs and damp. This one-off cost would cost the same as one year's expenditure on the Allowance, and would target the neediest far more effectively (note: this is merely a very high-level analysis). Overall, tackling fuel underconsumption and addressing Britain's bad record in excess winter deaths is admirable, but the devil lies in the detail. Of course, it may be that the Allowance's introduction had nothing to do this noble aim and was just to win marginal pensioner votes.

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APPENDIX 1: MEASURES NEEDED IN VULNERABLE FUEL POOR HOUSEHOLDS

	Estimated number of households (000s)	Average cost per household assumed	Total cost
Gas Central Heating - existing gas connection	270,000	£2,000	£550m
Has Central Heating - new connection required	60,000-90,000	£3,000	£170m-£270m
Boiler replacement	320,000	£1,000	£260m
Solid Wall insulation	130,000	£2,500-£4,000	£330m-£510m
Oil fired central hearing	90,000	£2,500-£3,500	£220m-£300m
High rise flats option 1 - CHP community heating	4,000	£5,000	£50m
High rise flats option 2 - electric storage heaters	4,000	£900	£8m
Cavity insulation	630,000	£300	£190m
Loft insulation	1,160,000	£200	£232m
Draft proofing	850,000	£100	£85m

Source: DTIc (2003), p. 5, *Table 3: Measures needed in vulnerable fuel poor households*

This shows the number of vulnerable fuel poor households estimated as needing each of the various measures, and the total estimated cost of providing these. There remain a large proportion of vulnerable fuel poor households needing basic measures like cavity wall and loft insulation. The WFA is received by 11.3m individuals, costing £1.9bn every year. These measures, if all implemented, would affect 3.5m households, costing £2.2bn in a one-off payment, although they would take longer to fully implement.

APPENDIX 2: COMPUTATION AND DEFINITION OF VARIABLES

Variable	Description	Details
BHPS		
log(ExpAll)	Computed from total yearly expenditure on fuel	
log(Income)	Computed from gross total yearly income.	
WFA/Income	Imputed, expressed in percent. WFA = Level of Winter Fuel Allowance, computed according to Table 1for each year, except all recipients in 1997-98, 1998-99 coded as having received £20.	
Winter	Winter dummy, taking value 1 if WFA of £100 or over received; 0 otherwise. This effectively means 1997-98, 1998-99 are control years, so the coefficient carries the interpretation: proportionate change in fuel expenditure for a WFA of £100 or more compared to getting a WFA of £20.	
Rooms	Number of rooms in house.	Data trimmed for rooms<11
House members	Number of household members.	Data trimmed for house members<10.
Employed	Number of employed people in household.	
Leaky roof, Damp floors, Rot	Dummy, taking value 1 if house has leaky roof, damp floors or rotting windows and doors; 0 otherwise.	
Detached	Dummy, taking value 1 if house detached house/bungalow; 0 otherwise.	
Semi-detached	Dummy, taking value 1 if house semi-detached house/bungalow, end terraced; 0 otherwise.	
Terraced	Dummy, taking value 1 if house terraced; 0 otherwise. Used as control.	
Flat	Dummy, taking value 1 if house flat (purpose-built, converted) ; 0 otherwise.	
Other house type	Dummy, taking value 1 if other house type (bedsitter, sheltered); 0 otherwise.	
Gas, Electricity, Oil, SolidFuel	Dummy, taking value 1 if heating provided by that method; 0 otherwise. Gas as control group.	
September etc.	Dummy, taking value 1 if interview conducted in that month; 0 otherwise.	
HoH age, HoH age under 30, HoH age under 80	Continous age term; age dummies, respectively.	
1997-2003	Year dummies. 2003 used as control year.	
Scotland etc.	Region dummies. London used as control. Imputed from BHPS regions. Regions redefined to match the ones in BMJ papers.	
Bad health	Dummy, taking value 1 if self reported health in very poor category; 0 otherwise.	5=Very poor health; 1=Best.
Temp above trend	Average yearly temperature by region for winter months, above trend from 1971-2004.	Imputed from 35 English weather stations from Met Office data (Scotland and Wales values taken from site). Calculated for each region by year for November, December, January temperature average.
EFS		
log(ExpAll)	Same as above, except computed from weekly amounts.	
log(Income)	Same as above, except computed from weekly amounts.	
Rooms	Number of rooms in house occupied	
Adults	Number of adults in household.	
Children	Number of children in household.	
HoH Unemployed	Dummy, taking value 1 if head of household unemployed; 0 otherwise.	
Slot, Account, Budget, Card	Dummy, taking value 1 if payment method is slot meter, account, budgeting scheme, or gas/ electricity card/disc; 0 otherwise. Account as control group.	Other methods of payment e.g. fully. Partly paid by DSS, and paid by someone outside household trimmed.

APPENDIX 3: FULL FINAL BHPS RESULTS

	Equation A:			Equation B			Equation C		
Dependent Variable	**log(Fuel Expenditure)**			**Fuel Expenditure/ Income**			**Fuel Expenditure/ Income**		
	Coef.	**Std. Err.**	**t-stat**	**Coef.**	**Std. Err.**	**t-stat**	**Coef.**	**Std. Err.**	**t-stat**
log(Income)	0.2864	0.0705	4.06	-3.3031	0.0966	-34.2	-36.4881	1.4395	-25.4
log(Income)^2	-0.0125	0.0036	-3.48	-	-	-	1.7106	0.0741	23.1
WFA/Income	-	-	-	0.5326	0.0676	7.88	0.1290	0.0664	1.94
Winter	2.4907	1.1163	2.23	-	-	-	-	-	-
Winter*log(Income)	-0.4853	0.2241	-2.17	-	-	-	-	-	-
Winter*log(Income)^2	0.0236	0.0112	2.1	-	-	-	-	-	-
Controls									
Rooms	0.1125	0.0089	12.67	0.7402	0.1243	5.95	0.7422	0.1179	6.29
Rooms^2	-0.0038	0.0007	-5.14	-0.0453	0.0135	-3.35	-0.0497	0.0128	-3.87
House members	0.2282	0.0113	20.14	0.9065	0.2018	4.49	0.5674	0.1920	2.95
House members ^{2}	-0.0106	0.0016	-6.6	-0.1011	0.0364	-2.78	-0.0866	0.0345	-2.51
Employed	-	-	-	0.1513	0.0691	2.19	0.1038	0.0656	1.58
Leaky roof	0.0276	0.0143	1.93	-0.1963	0.1599	-1.23	-0.2030	0.1515	-1.34
Damp floors	0.0465	0.0110	4.24	0.0708	0.1171	0.6	0.0647	0.1109	0.58
Rot	0.0374	0.0102	3.68	0.1790	0.1003	1.78	0.1786	0.0950	1.88
Detached	0.1358	0.0126	10.78	0.7844	0.1344	5.84	0.6354	0.1277	4.98
Semi-detached	0.0422	0.0098	4.31	0.1911	0.1018	1.88	0.1765	0.0965	1.83
Flat	-0.0559	0.0144	-3.88	0.0146	0.1379	0.11	-0.0043	0.1308	-0.03
Other house type	-0.0852	0.0309	-2.76	-0.2143	0.2110	-1.02	-0.3762	0.2001	-1.88
Electricity	-0.0125	0.0136	-0.92	-0.0710	0.1208	-0.59	-0.0831	0.1146	-0.73
Oil	0.1763	0.0193	9.13	0.5917	0.2038	2.9	0.6427	0.1933	3.32
Solid Fuel	0.1040	0.0253	4.12	0.4551	0.2506	1.82	0.6138	0.2378	2.58
September	-0.0280	0.0130	-2.15	-0.2018	0.0798	-2.53	-0.2080	0.0756	-2.75
October	-0.0366	0.0132	-2.77	-0.2308	0.0849	-2.72	-0.2429	0.0805	-3.02
November	-0.0100	0.0147	-0.68	-	-	-	-	-	-
December	-0.0301	0.0202	-1.49	-	-	-	-	-	-
HoH age	-	-	-	-0.0024	0.0018	-1.35	-0.0028	0.0017	-1.62
HoH age under 30	-0.0706	0.0066	-10.6		-	-	-	-	-
HoH age over 80	-0.0752	0.0191	-3.94	-	-	-	-	-	-
1997	0.0547	0.0094	5.82	-0.3346	0.0739	-4.53	-0.2839	0.0700	-4.05
1998	0.0065	0.0088	0.73	-0.5350	0.0869	-6.16	-0.2161	0.0835	-2.59
1999	-0.0081	0.0083	-0.97	-0.7375	0.1014	-7.28	-0.2782	0.0981	-2.84
2000	-0.0100	0.0082	-1.21	-0.7913	0.1199	-6.6	-0.2237	0.1163	-1.92
2001	-0.0132	0.0084	-1.58	-0.8238	0.1208	-6.82	-0.2291	0.1173	-1.95
2002	-0.0131	0.0088	-1.49	-0.8043	0.1222	-6.58	-0.2345	0.1184	-1.98
Scotland	0.1946	0.0214	9.1	0.6431	0.2106	3.05	0.6495	0.2002	3.25
Wales	0.1180	0.0327	3.61	-	-	-	-	-	-
North	0.0268	0.0163	1.65	-	-	-	-	-	-
Trent	-0.0358	0.0206	-1.74	-	-	-	-	-	-
West Midlands	-0.0121	0.0250	-0.48	-	-	-	-	-	-
North West	0.0377	0.0256	1.47	-	-	-	-	-	-
East	-0.1364	0.0368	-3.7	-	-	-	-	-	-
South East	-0.0397	0.0176	-2.26	-	-	-	-	-	-
South West	-0.0615	0.0245	-2.51	-	-	-	-	-	-
Bad Health	-0.0133	0.0158	-0.84	0.1204	0.1180	1.02	0.1339	0.1117	1.2
Temp above trend	0.0106	0.0074	1.43	-0.0649	0.0390	-1.66	-0.0911	0.0370	-2.46
Constant	3.8276	0.3508	10.91	32.3108	0.9646	33.5	193.3392	7.0307	27.5
Hausmann test (χ2)	148.5			110.55			99.13		
No of observations	22160			4726			4726		
Overall R^2	0.3284			0.4407			0.4886		

APPENDIX 4: FULL EFS RESULTS

	Equation D			Equation E			Equation F		
Dependent Variable	**log(Fuel Expenditure)**			**Fuel Expenditure/ Income**			**Fuel Expenditure/ Income**		
	Coef.	**Std. Err.**	**t-stat**	**Coef.**	**Std. Err.**	**t-stat**	**Coef.**	**Std. Err.**	**t-stat**
log(Income)	0.0457	0.0084	5.42	-0.7682	0.0198	-38.9	-3.9871	0.1256	-31.7
log(Income)2	-	-	-	-	-	-	0.3054	0.0118	25.9
WFA/Income	-	-	-	1.3185	0.0329	40	1.2900	0.0324	39.8
Slot	-	-	-	-0.0559	0.0246	-2.08	-0.0463	0.0265	-1.75
Budget	-	-	-	-0.0471	0.0246	-1.91	-0.0559	0.0242	-2.31
Card	-	-	-	-0.2225	0.0294	-7.57	-0.1886	0.0289	-6.52
Gas - Slot	0.1120	0.0636	1.76	-	-	-	-	-	-
Gas - Budget	0.0865	0.0121	7.12	-	-	-	-	-	-
Gas - Card	0.1005	0.0190	5.29	-	-	-	-	-	-
Electricity - Slot	-0.0549	0.0430	-1.28	-	-	-	-	-	-
Electricity - Budget	0.0478	0.0112	4.25	-	-	-	-	-	-
Electricity - Card	-0.0056	0.0152	-0.37	-	-	-	-	-	-
Controls									
Electricity	0.0676	0.0182	3.71	-0.0413	0.0426	-0.97	-0.0437	0.0419	-1.04
Oil	0.2156	0.0185	11.7	0.0199	0.0436	-1.08	-0.002995	0.0429	-0.07
Gas	0.0220	0.0132	1.67	-0.046971	0.0306	0.65	0.0053	0.0301	0.18
Rooms	0.1132	0.0110	10.3	0.0038	0.0070	0.55	-0.0156	0.0069	-2.26
Rooms^2	-0.0031	0.0008	-3.82	-	-	-	-	-	-
Detached	0.0910	0.0120	7.56	0.0712	0.0283	2.52	0.0036	0.0279	0.13
Semi-detached	0.0361	0.0099	3.63	0.0110	0.0233	0.47	0.0002	0.0229	0.01
Flat	-0.1468	0.0149	-9.84	0.0099	0.0335	0.3	-0.0229	0.0330	-0.69
Other house type	0.0406	0.0198	2.05	0.0099	0.0456	-0.6	-0.0935	0.0448	-2.08
Adults	0.1671	0.0198	8.44	0.1961	0.0464	4.23	0.1636	0.0456	3.59
Adults^2	-0.0098	0.0042	-2.34	-0.0250	0.0098	-2.54	-0.0233	0.0097	-2.41
Children	0.1074	0.0100	10.7	-0.0686	0.0234	-2.93	-0.0594	0.0230	-2.58
Children^2	-0.0115	0.0029	-3.96	0.0142	0.0068	2.09	0.0140	0.0067	2.1
Employed	-0.0219	0.0064	-3.4	-0.0218	0.0152	-1.43	-0.1081	0.0153	-7.07
HoH unemployed	-0.0534	0.0288	-1.86	-0.7732	0.0675	-11.5	-0.9361	0.0666	-14.1
HoH age	0.0569	0.0072	7.92	0.2326	0.0172	13.5	0.2284	0.0169	13.5
HoH age^2	-0.0027	0.0004	-7.67	-0.0058	0.0009	-6.78	-0.0053	0.0008	-6.26
Interview in Q3	-0.0093	0.0107	-0.87	0.0354	0.0251	1.41	0.0328	0.0246	1.33
Interview in Q2	0.1034	0.0107	9.64	0.0073	0.0252	0.29	0.0119	0.0247	0.48
Interview in Q1	0.1271	0.0106	11.9	0.0202	0.0250	0.81	0.0173	0.0245	0.71
2001	0.0066	0.0092	0.72	-0.0638	0.0220	-2.9	-0.0652	0.0216	-3.02
2002	-0.0008	0.0094	-0.08	-0.0902	0.0223	-4.04	-0.0924	0.0219	-4.21
Scotland	0.0874	0.0172	5.1	-0.0196	0.0402	-0.49	0.0172	0.0395	0.43
Wales	-0.0776	0.0199	-3.9	-0.0990	0.0467	-2.12	-0.0403	0.0460	-0.88
North	-0.0696	0.0148	-4.72	-0.0383	0.0346	-1.11	-0.0403	0.0341	0.32
Trent	-0.1439	0.0181	-7.97	0.0571	0.0424	1.35	0.0110	0.0417	2.82
West Midlands	-0.1023	0.0171	-5.98	-0.0210	0.0401	-0.52	0.1175	0.0395	0.74
North West	-0.0654	0.0168	-3.9	-0.0386	0.0394	-0.98	0.0292	0.0387	-0.01
East	-0.1111	0.0167	-6.66	0.0478	0.0391	1.22	-0.0003	0.0385	1.97
South East	-0.1173	0.0152	-7.72	0.0215	0.0356	0.6	0.0757	0.0350	0.94
South West	-0.0999	0.0164	-6.08	-0.0677	0.0386	-1.76	0.0330	0.0379	-0.67
Constant	0.8904	0.0638	14	3.1799	0.1361	23.4	11.6757	0.3538	33
No of observations	18914			18914			18914		
F-Test	160.11			307.46			328.24		
Adjusted R^2	0.2422			0.3619			0.3838		

APPENDIX 5: ANCILLARY BHPS AND EFS RESULTS

	Equation B':			Equation B'':		
Dependent Variable	Fuel Expenditure/ Income			Fuel Expenditure/ Income		
	Coef.	Std. Err.	t-stat	Coef.	Std. Err.	t-stat
log(Income)	-3.54977	0.1332	-26.66	-3.1256	0.1009	-30.98
WFA/Income	1.40683	0.0735	19.15	1.3505	0.0417	32.35
Controls						
Rooms	0.77469	0.1414	5.48	0.6875	0.1129	6.09
$Rooms^2$	-0.0328	0.0125	-2.62	-0.0253	0.0103	-2.46
House members	0.86025	0.2340	3.68	0.8235	0.1424	5.78
House $members^2$	-0.06632	0.0328	-2.02	-0.0538	0.0158	-3.41
Employed	0.27569	0.1165	2.37	0.2226	0.0831	2.68
Leaky roof	-0.1716	0.3231	-0.53	-0.1846	0.2283	-0.81
Damp floors	-0.01876	0.2432	-0.08	-0.0237	0.1697	-0.14
Rot	0.46144	0.2151	2.14	0.4996	0.1488	3.36
Detached	1.00946	0.2188	4.61	0.9166	0.1692	5.42
Semi-detached	0.32171	0.1817	1.77	0.2992	0.1347	2.22
Flat	0.14948	0.2339	0.64	0.1703	0.1768	0.96
Other house type	-0.62659	0.4112	-1.52	-0.2910	0.2965	-0.98
Electricity	0.09694	0.2055	0.47	-0.0505	0.1566	-0.32
Oil	0.19337	0.3276	0.59	0.7467	0.2455	3.04
Solid Fuel	0.22034	0.3897	0.57	0.8635	0.3172	2.72
September	-0.44597	0.1987	-2.24	-0.2704	0.1179	-2.29
October	-0.33269	0.2119	-1.57	-0.2746	0.1261	-2.18
HoH age	-0.00138	0.0034	-0.4	-0.0008	0.0025	-0.31
1997	-0.4809	0.1277	-2.34	-0.1805	0.1176	-1.54
1998	-0.12221	0.1305	-0.94	-0.9295	0.1247	-7.46
1999	-0.84549	0.1396	-6.06	-1.4449	0.1307	-11.05
2000	-1.33523	0.1500	-8.9	-1.7362	0.1487	-11.68
2001	-1.3801	0.1281	-7.9	-1.7123	0.1526	-11.22
2002	-1.4991	0.1425	-9.4	-1.6640	0.1433	-11.61
Scotland	0.60429	0.2677	2.26	0.5145	0.2634	1.95
Wales	-	-	-	0.0985	0.3613	0.27
North	-	-	-	-0.0239	0.1923	-0.12
Trent	-	-	-	-0.4564	0.2658	-1.72
West Midlands	-	-	-	-0.1444	0.2922	-0.49
North West	-	-	-	-0.1011	0.2983	-0.34
East	-	-	-	-0.9421	0.4874	-1.93
South East	-	-	-	-0.0663	0.2171	-0.31
South West	-	-	-	-0.7816	0.3067	-2.55
Bad Health	-0.11081	0.0580	-1.91	0.0984	0.1062	0.93
Temp above trend	0.3196	0.2556	1.25	0.1239	0.1810	0.68
Constant	34.1201	1.2816	26.62	30.3594	1.0020	30.3
Hausmann test ($\chi 2$)	388.97			191.03		
No of obs	2829			5079		
Overall R^2	0.4761			0.5109		

These regressions reflect Equation B above, with two sets of modifications: B' places the additional restriction that WFA amount>Fuel Expenditure, to test whether mental accounting holds in Case 1; B'' removes all restrictions. The intention with the latter is to determine how robust the final results are even when reasonable restrictions are lifted.

The main result of interest is that β^{E}_{WFA} remains constantly under one.

	Equation E':			Equation E'':		
Dependent Variable	Fuel Expenditure/ Income			Fuel Expenditure/ Income		
log(Income)	-5.7718	2.9920	-1.93	-0.6715	0.1172	-5.73
WFA/Income	-0.1922	0.8860	-0.22	1.3348	0.0689	19.36
Slot	-0.3737	0.2942	-1.27	-0.0474	0.0315	-1.5
Budget	-0.0362	0.1414	-0.26	-0.0486	0.0257	-1.89
Card	-0.8539	0.6249	-1.37	-0.2135	0.0404	-5.28
Controls						

Analogously, these regressions reflect Equation E. Evidence on β^{E}_{WFA} is mixed, but notice a large part of the dataset is lost with E'. Interestingly, the coefficients for method of payment remain largely comparable to E, suggesting our results are robust.

Rooms	0.2644	0.2033	1.3	0.0133	0.0130	1.03
Adults	2.7741	2.6927	1.03	0.1197	0.1044	1.15
$Adults^2$	-0.3346	0.4631	-0.72	-0.0118	0.0160	-0.74
Children	0.9660	0.8725	1.11	-0.0655	0.0145	-4.53
$Children^2$	-	-	-	0.0127	0.0034	3.72
HoH unemployed	-2.5792	2.1995	-1.17	-0.7187	0.0849	-8.46
HoH age	-9.7042	9.0058	-1.08	0.2234	0.0197	11.32
HoH age^2	0.3399	0.3205	1.06	-0.0054	0.0012	-4.33
Employed	0.3664	0.3846	0.95	-0.0351	0.0260	-1.35
Detached	0.8780	0.6615	1.33	0.0695	0.0444	1.57
Semi-detached	0.1025	0.1616	0.63	0.0102	0.0155	0.66
Flat	0.2707	0.2309	1.17	0.0363	0.0279	1.3
Other house type	0.0994	0.3680	0.27	0.0003	0.0392	0.01
Electricity	-0.1194	0.2211	-0.54	-0.0362	0.0600	-0.6
Oil	-0.5809	0.5572	-1.04	-0.0599	0.0750	-0.8
Gas	-0.2899	0.3278	-0.88	0.0206	0.0424	0.48
Quarter 3	0.1858	0.2561	0.73	0.0369	0.0283	1.3
Quarter 2	0.0843	0.1901	0.44	0.0131	0.0189	0.69
Quarter 1	-0.1126	0.1654	-0.68	0.0229	0.0203	1.13
2001	-1.3267	1.1629	-1.14	-0.0553	0.0230	-2.41
2002	-1.1057	0.9167	-1.21	-0.0812	0.0167	-4.87
Scotland	-0.2117	0.3431	-0.62	-0.0369	0.0292	-1.26
Wales	-0.1973	0.2601	-0.76	-0.1188	0.0371	-3.2
North	-0.0795	0.2112	-0.38	-0.0573	0.0294	-1.95
Trent	0.9634	0.9157	1.05	0.0356	0.0619	0.58
West Midlands	-0.3147	0.2834	-1.11	-0.0420	0.0368	-1.14
North West	0.2753	0.3379	0.81	-0.0599	0.0313	-1.91
East	0.0651	0.2639	0.25	0.0337	0.0320	1.05
South East	0.2680	0.3161	0.85	0.0068	0.0283	0.24
South West	0.0776	0.2786	0.28	-0.0821	0.0318	-2.58
Constant	97.9019	75.4010	1.3	2.7422	0.4915	5.58
No of observations	707			20047		
F-Test	15.56			566.65		
Adjusted R2	0.4349			0.3609		

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