Does warmth make you feel better?

Oleg Badunenko[a], Helena Meier[b]

[a]*Cologne Graduate School in Management, Economics and Social Sciences (CGS), University of Cologne, Albertus-Magnus-Platz, 50923 Cologne, Germany.*

[b]*Department of Economics, Institute of Energy Economics, University of Cologne, Vogelsanger Straße 321, 50827 Cologne, Germany*

Abstract

Rising energy prices and ambitious carbon reduction targets increase energy bills of households that want to maintain a certain level of comfort. Whether this has an impact on the quality of life and its integral part, health satisfaction, is not entirely clear. We develop a theoretical model where endogenously given energy spending is linked to health satisfaction. This model is tested using British panel household survey dataset with more than 60,000 observations covering the period 1998 to 2007. Our results suggest that satisfaction decreases in energy spending. Furthermore, gas and electricity spending have a detrimental effect on perception of health too.

Keywords: Health satisfaction, Energy spending, Simultaneous equation model
JEL: D12, R21, Q41

1. Introduction

Given recent developments of energy prices and ambitious carbon reduction targets the question arises to what extent they impact on people's lives. Households facing difficulties paying their energy bills will suffer from the inability of keeping their homes warm and inadequate housing conditions, which will carry over to overall life discontent, health dissatisfaction being the major domain of it.[1] We conjecture that health dissatisfaction causes costs for society that are twofold. It can lead to a lower productivity of individuals; in medical literature it has already been proven that there is a causal link between home heating and objective health: inadequate heating can cause respiratory illnesses (e.g. Somerville, MacKenzie, Owen, and Miles, 2000; BMJ, 2008) and is connected to the occurrence of excess winter mortality (e.g. Aylin, Morris, Wakefield, Grossinho,

[1]Several Europe-wide initiatives have already been directed at helping particularly vulnerable households increasingly known as fuel power (e.g. The ACHIEVE project (`http://www.achieve-project.eu/`).

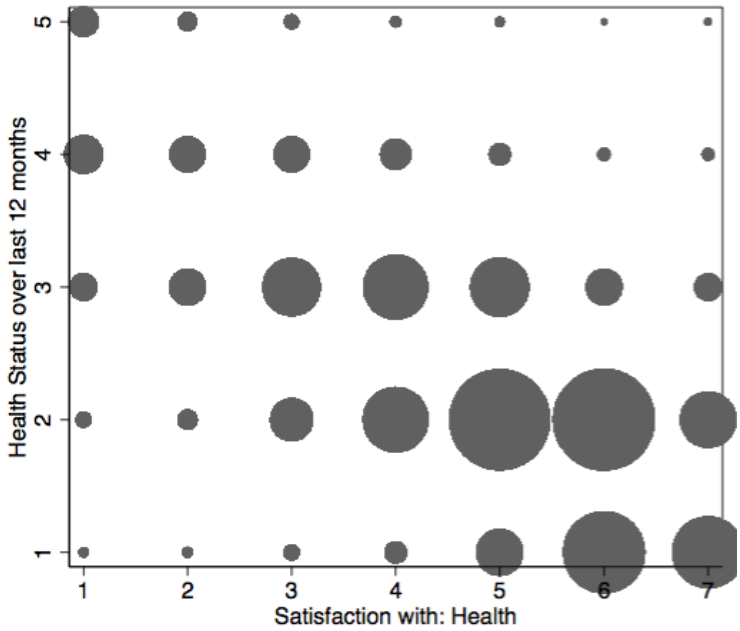

Figure 1: Health status (1=excellent, 5=very poor) and health satisfaction (1=dissatisfied, 7=completely satisfied). Own presentation, data drawn from the BHPS.

Jarup, and Elliott, 2001). The inability of keeping adequately warm at home is also linked to an increased burden for the financial system because of a higher number (than what the objective status would suggest) of doctoral visits. By the transitivity property in the long run, higher energy spending bills are going to increase the costs in the society. In this paper the major focus is on the link between thermal comfort, i.e. the ability to keep adequately warm and health satisfaction.

Although an ability to warm the dwelling reflects on satisfaction with housing to a large extent, there is a difference between such an ability and the overall satisfaction with housing. Whereas the satisfaction with housing takes various objective and subjective housing conditions, the ability to warm the dwelling only concerns supporting the minimal necessary condition of living. The current total energy spending of the household incorporates plenty of subtle information on a household, such as the changes to past spendings, comparisons of spendings to those of neighbors and relatives, and thus echoes the perception of the ability to pay the bill and therefore the ability to keep the home warm. The link between energy spending and health satisfaction will be the major focus of this analysis.

This study focuses on health satisfaction as a subjective measure rather than on the objective health status. Fig. 1 suggests that people with a good health status do not necessarily have a high level of health satisfaction and vice versa. While there is a big overlap between objective

health and health satisfaction, given the multidimensionality of health satisfaction there are other factors than objective health driving health satisfaction. In economic literature, different links between (objective) health and specific factors have been explored. These include the impact of socio-economic status (e.g. Adams, Hurd, McFadden, Merrill, and Ribeiro, 2003), the link between children's health and household economic status (Case, Lubotsky, and Paxson, 2002) or between health and lifestyle (Contoyannis and Jones, 2004). In happiness research, a much explored driver of happiness is income (e.g. Easterlin, 2001). Next to income other factors such as age, education, number of children and gender have been analysed in the context of health satisfaction (e.g. Van Praag and Ferrer-i Carbonell, 2008). In this study, we are interested in thermal comfort i.e. the ability of keeping warm at home as a driver of subjective well-being to learn about how households perceive their situation.

Housing consists of several aspects. Many of them, such as internal decorations, furniture etc. are at the command of the dweller whereas energy spending is mostly determined by the actual dwelling characteristics and by the energy provider, whose conditions are in turn driven by the energy market.[2] The aim of the analysis is to investigate the effect of something that is out of the household's control, but that has an enormous impact on the perception of the housing quality, on the perceived quality of life of which health satisfaction comprises a huge part.

Energy spending might impact on health satisfaction, which, as Fig. 2 suggests, is virtually time-invariant, in several ways. Suppose that households spending a high share of their budget on energy will be less satisfied with their housing and thus with their health. Fig. 3 on the contrary shows that households spending a high share of their budget on gas (which is mainly used for heating) are not systematically less satisfied with their health. I.e. a relatively high gas bill does not guarantee a low level of satisfaction. In general, there are three possible scenarios of a household's level of energy spending. Households can (i) underspend, i.e. use too little energy, (ii) spend just about the right amount or (iii) overspend, i.e. spend too much on energy. If they underspend it could either not matter to household members and thus have no impact on satisfaction or they can experience it as a deprived situation and thus be dissatisfied. If they spend just about the right amount, we would expect these households to live in good housing conditions and thus be

[2]Energy savings potentials are driven by physical, technical as well as behavioural components. For reductions in gas spending however, structural characteristics are most crucial while for a reduced electricity spending household economic behaviour also plays an important role (e.g. Brounen, Kok, and Quigley, 2012). Here, we assume that households have adapted to external circumstances as far as possible and that they now have to accept the level of energy spending for a certain level of comfort or they simply have to lower their demands for comfort. Thus, all savings potentials with respect to behaviour have been realised (like e.g. wearing warmer clothes and lowering the indoor temperature). Also, the household is economically not able to undertake [further] efficiency investments.

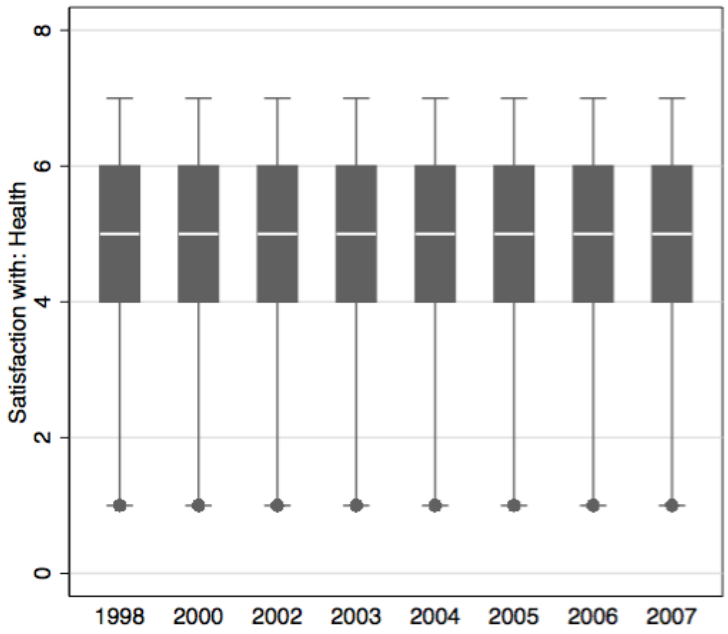

Figure 2: Health satisfaction over time. Own presentation, data drawn from the BHPS.

satisfied. If they overspend they could be satisfied if this implies it is sufficiently warm at home or it is simply the utility maximising level of energy spending. If they have to overspend because of bad insulation or bad housing in general it could imply that they are dissatisfied also because it leaves fewer options for spending on other goods.

In this subjective context, we focus on total energy spending rather than on relative energy spending.[3] In terms of the subjective measure of health, we purport that it is the total spending that matters the most. The relative energy spending (per income, per room, per sqm) may and probably will have an influence on health satisfaction. But we consider this to be a conceptual mismatch. More specifically, relative energy spending is the hard type information, an indicator, regarding housing, which should effect the hard type information about individual's health, namely, the objective health status indicator. Whereas, analysing this realtionship is an important piece of analysis, it will not be pursued here. Rather, we want to distinguish the soft information about the housing, the perception of housing quality reflected in thermal comfort and analyse its impact on the soft type part of health, namely, how individuals perceive their health.

[3]If individuals compare energy bills, be it previous dwellings or neighbours, they will compare total bills rather than energy bills related to the exact size of the house, the number of rooms or the levels of available incomes. (While income of neighbors or acquaintances is usually quite a sensitive information, energy bill is less so and thus easier to compare.)

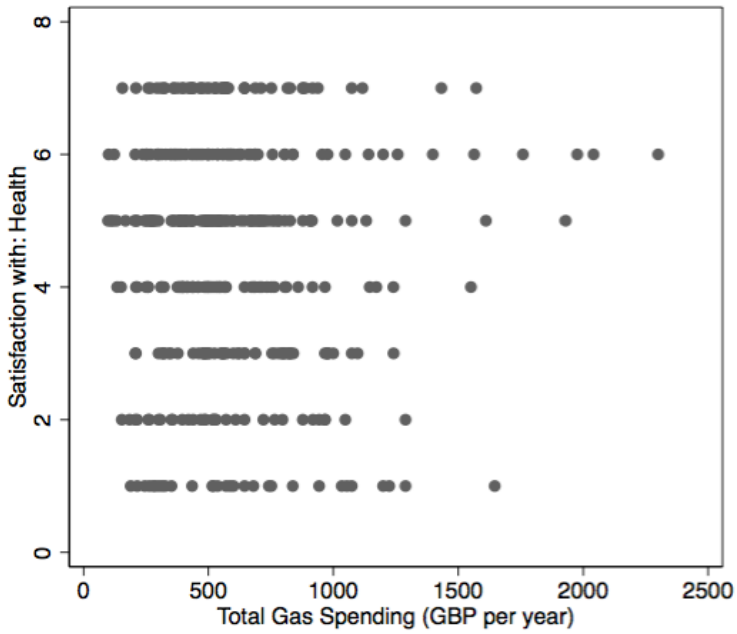

Figure 3: Health satisfaction and total gas spending for households spending more than 10 % of their income on gas. Own presentation. Based on the BHPS.

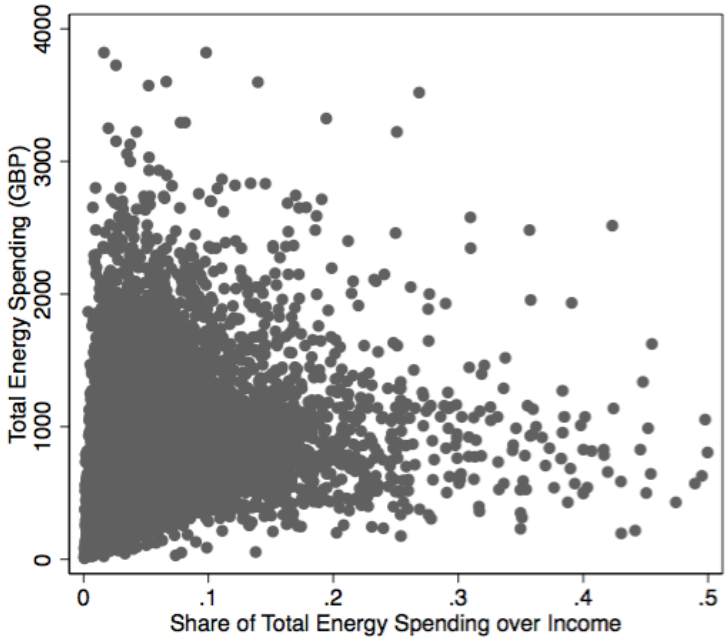

Figure 4: Total energy spending and share of total energy spending over income. Own presentation, data drawn from the BHPS.

Fig. 4 shows that there is no clear pattern between total energy spending and relative energy spending. Looking at these two measures in the context of health satisfaction as presented in Fig.

5, they still differ. It remains unclear in howfar energy spending and housing impact on the quality

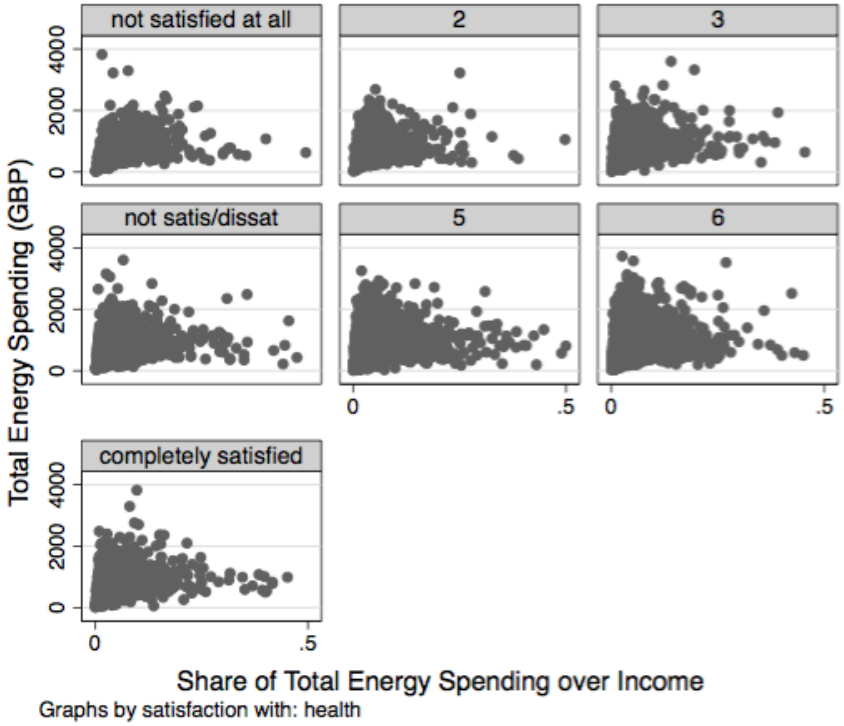

Figure 5: Total energy spending and share of total energy spending over income by levels of health satisfaction. Own presentation, data drawn from the BHPS.

of life in general and, in particular, on health satisfaction. Exploring this link can give further insights into how people actually perceive a constrained situation and tell more about its impacts on a society's subjective well-being rather than looking simply at economic indicators. We cannot say anything about sacrifices people make. If people were to spend more on energy they will have to make sacrifices within other areas of lifestyle and e.g. reduce their food consumption. We assume that habits and behvaviour of individuals remain the same. Here, we want to explore if there is a direct, significant link between energy spending and health satisfaction. We hypothesise that higher energy spending and in particular higher spending on heating fuels imply difficulties with keeping adequately warm at home and thus a situation of bad housing. We further claim that bad housing decreases health satisfaction.

In contrast to previous studies and in line with the argumentation that energy spending is out of household control, we treat energy spending as an endogenous variable. In a past study (e.g. Meier, 2010), energy spending was used as an exogenous variable in this context and as a consequence, results were not plausible. More specifically, our estimation strategy involves a simultaneous

equation model where health satisfaction and energy spending are determined simultaneously. Our results indeed show that energy spending does have negative significant impacts on health satisfaction. The same applies when gas and electricity spending are considered separately. I.e. the higher the spending on different fuels the lower the health satisfaction of individuals.

The paper unfolds as follows. The next section describes the theoretical and econometric model as the basis of our analysis followed by a description of the data used. Section four gives the results and section five concludes.

2. Model

In this section, we describe the underlying theoretical model and then explain the econometric strategy of the analysis.

2.1. Theoretical Model

Fig. 6 depicts causal paths between quality of life, health satisfaction and energy spending. The overall quality of life is determined by satisfaction within different domains of life, health being one of them. Individuals rank health satisfaction according to their preferences that are impacted on by a range of factors. In general, the intuitive health satisfaction drivers are the objective health status of individuals, socio-economic characteristics such as income and age as well as behavioural characteristics, e.g. whether somebody smokes or not. Housing constitutes a further group of satisfaction drivers. In our model it is determined by factors attributed to energy spending and household income. At the same time, energy spending is determined by drivers such as energy prices and building characteristics. Socio-economic characteristics are presented in both boxes – as much as they determine the quality of life of individuals they determine energy spending, at the same time. While there are many aspects of overall quality of life, we concentrate on the link between housing and health satisfaction, shown by the red dashed arrow, while also taking into account the other relationships depicted by solid arrows in the graph.

What Fig. 6 does not show is the mechanism that determines its key components. Given above argumentation, the relationship between health satisfaction and energy spending is expected to be downward sloping. This relationship may be roughly considered to be a “demand” for energy spending. On the other hand, the energy spending is pushed by the external forces such

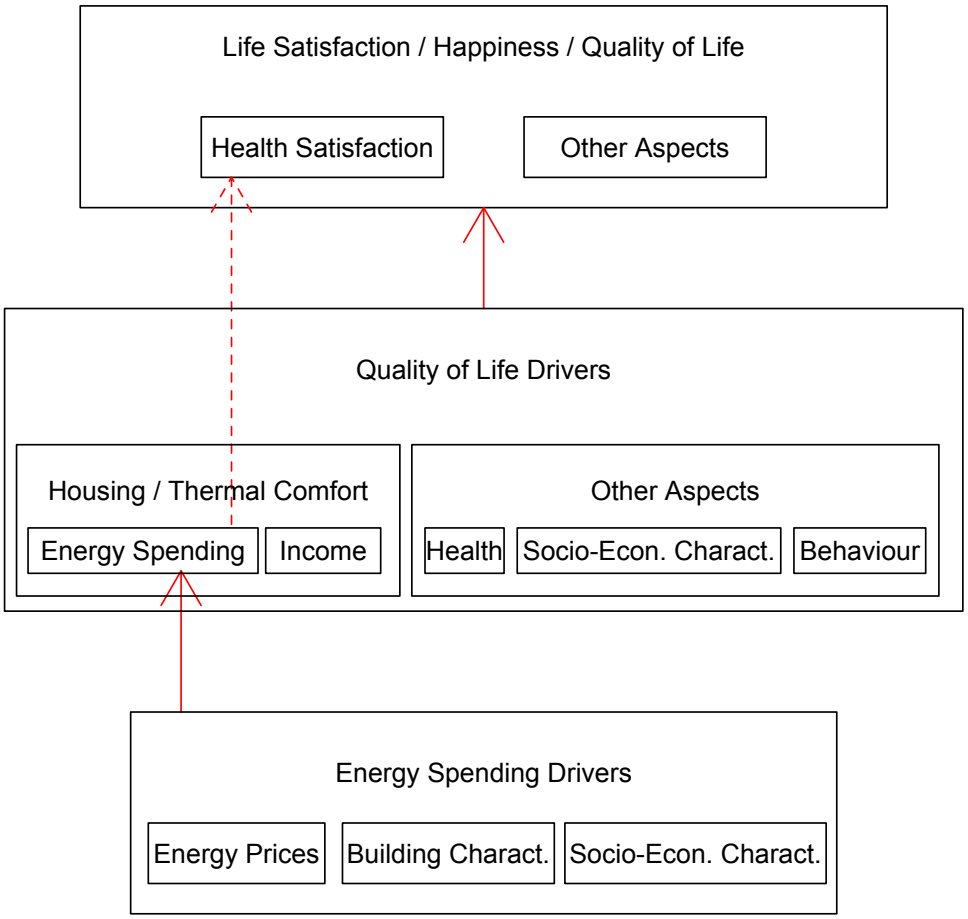

Figure 6: Theoretical model

as the energy price. These external forces are positive shifters, which renders the upward sloping relationship between them and energy spending, thus ascribing this relationship the role of the "supply" of energy spending. We do not observe various combinations of health satisfactions and energy spending, but rather, we observe some equilibrium values for each and every household once "demand" and "supply" clear.

2.2. Econometric Model

The causal relationships as described in the theoretical model need to be addressed in the econometric approach. While the model predicts the influence of energy spending on health satisfaction, energy spending depends on a number of other factors at the same time. Accordingly, the estimation strategy needs to take into account that health satisfaction and energy spending are determined simultaneously, thus rendering a system of two equations,

$$H_{it} = \alpha_0 + \alpha_1 X_{it} + \alpha_2 E_{it} + \gamma_i + \epsilon_{it} \tag{1}$$

$$E_{it} = \beta_0 + \beta_1 Z_{it} + \delta_i + \nu_{it}, \tag{2}$$

where Eq (1) represents the relationship between middle and upper boxes in Fig. 6 and Eq (2) represents the relationship between lower middle and middle boxes in Fig. 6. H is the health satisfaction of an individual (each variable is for individual i at time t). E is the energy spending, X is a vector of health status and behaviour of an individual (a vector of quality of life drivers), Z is a vector of energy spending drivers, γ_i and δ_i are fixed effects in Eq (1) and Eq (2), respectively, and ϵ_{it} and ν_{it} are the error terms.

We are primarily interested in estimating Eq (1), which contains potentially endogenous variable E, energy spending. Applying the standard regression for panel data for this equation will yield inconsistent estimate of the coefficients at E and variables in X. If we find valid instruments for E, we can use instrumental variable (IV) regression for panel data to get consistent estimates. Due to our model prediction and the nature of the simultaneous equation model the potential instruments are readily available, namely variables in vector Z that do not appear in vector X. Since according to our model socio-economic characteristics appear in both Z and X, the instruments for potentially endogenous variable E will be energy prices and building characteristics.[4]

The daunting issue is whether health satisfaction causes energy spending. Whereas there might be arguments for and against this direction of the effect, let's see what does it imply econometri-

[4] H is a discrete variable ranging from 1 to 7 (completely satisfied). Given an individual's utility, this discrete response structure has an underlying continuous range of preferences. Even though only discrete values H are observed, it is assumed that each of these values reflects an interval around the underlying satisfaction levels H^*. I.e. if $H = 1$ we can say that H^* is larger than zero and smaller than some threshold parameter (Greene, 2012). For the empirical analysis, an ordered probit model would be the desired approach. Ferrer-i Carbonell and Frijters (2004), however, have shown that it is not decisive for the analysis whether cardinality or ordinality is assumed. Instead, they state that unobserved heterogeneity is crucial for the estimation. Individual fixed effects or at least individual time-invariant personality traits thus need to be taken into account.

cally if it were true. Eq (2) would become

$$E_{it} = \beta_0 + \beta_1 Z_{it} + \lambda H_{it} + \delta_i + \nu_{it}. \tag{3}$$

Since we are solely interested in estimating the health satisfaction equation, Eq (1), but not in analysing the energy spending equation, Eq (2), Eq (3) instead of Eq (2) in the original system does not change the instruments for analysis of Eq (1). Thus the possible reverse causality does not change our estimation strategy.

3. British Household Data

The data used is based on the British Household Panel Survey (BHPS)[5]. The BHPS is an unbalanced panel of more than 5,000 households. We use a sample period from 1998 to 2007 where data on perceived satisfaction levels in different domains of life like, e.g. health and information on energy spending is jointly available (with the exception of 2001). Besides this subjective health variable (SHEALTH), the dataset contains dummy variables indicating (objective) health problems. These cover chest/breathing problems, asthma, bronchitis (CHEST), heart/blood pressure or blood circulation problems (HEART) and problems or disability connected with: arms, legs, hands, feet, back, or neck (including arthritis and rheumatism) (EXTREMITIES). SMOKER indicates whether an individual is a smoker or not and DISABLED indicates disability. The measured variables for Eq (1) and Eq (2) are as follows:

H_{it} Satisfaction with health, 1: Not satisfied at all, 4: Not satisfied/dissatisfied, 7: completely satisfied.
Variable occurrence: Waves 6-10, 12-18.

X_{it} Vector of following variables:
1. Average household age.
2. Annual household income.
3. Number of people in household.

Dummies:
1. Marital status of head of household (married, widowed, divorced, never married).
2. Whether head of household is a smoker or not.
3. Whether head of household is disabled or not.

[5] A description of the BHPS can be found here: `https://www.iser.essex.ac.uk/bhps`.

4. Whether head of household has the following health problems, or not: with chest/breathing, heart/blood pressure, pain with arms, legs, hands, etc.

t, t^2 Linear trend ($t = 1, \ldots, 10$ for $1998, \ldots, 2007$) and trend squared.

E_{it} Annual spending on energy (sum gas electricity and oil).

Z_{it} Vector of following variables:

1. Prices: Annual fuel price.
2. Number of rooms in dwelling.
3. Average household age.
4. Annual household income.
5. Number of people in household.

Dummies:

1. Accommodation problems: condensation, rot in windows/floors, leaky roof, damp walls/floors etc.
2. Building types: Detached and semi-detached, terraced and end-terraced houses or flat.

E_{it} is the annual amount a household spends on fuels, i.e. the sum of spending on gas, electricity and oil. While gas is a heating fuel, electricity can be used for both, heating and technical appliances. Gas spending is directly linked to the extent a heating is used. E_{it} though is an endogenous variable, as it is itself determined by a range of factors. The determinants of energy spending are considered as mainly discussed in literature: energy prices, building characteristics as well as socio-economic circumstances of households/individuals. Although we admit that households select the dwellings they live in, the choices of homes are however limited and constrained by economic factors which we control for. It might be argued that building characteristics should not be instruments for energy spending. We do not exclude this possibility and will control for it in the empirical section. Here, the energy spending equation is basically the demand side equation and supply side instruments are not considered. Since households are more or less price takers and switching rates tend to be rather low, we assume that the supply side factors do not matter to a household's spending "decision." Thus, we treat energy spending as endogenous and consider it to be determined by a household's possibilities.

We further use data on annual households spending on different fuels available within the survey. In order to capture the effect of price developments, we match the BHPS with annual data on average regional energy prices for gas and electricity. The Department of Energy and Climate Change (DECC, 2013) provides average unit costs for electricity and gas for selected towns and

Table 2: Summary Statistics (BHPS sample)

	sd	p1	p25	mean	p50	p75	p99
SHEALTH	1.597	1.000	4.000	4.865	5.000	6.000	7.000
ENERGY SPENDING	354.222	152.818	496.657	723.499	660.580	879.765	1886.792
ELECTRICITY SPENDING	186.539	65.862	219.539	340.904	306.122	419.287	979.592
GAS SPENDING	218.213	30.612	246.000	375.643	343.840	477.555	1074.114
AVERAGE AGE	0.510	2.539	3.245	3.655	3.664	4.119	4.454
INCOME	0.753	8.200	9.488	10.005	10.090	10.549	11.541
HOUSEHOLD SIZE	0.534	0.000	0.693	0.788	0.693	1.099	1.792
MARRIED	0.499	0.000	0.000	0.530	1.000	1.000	1.000
WIDOWED	0.331	0.000	0.000	0.125	0.000	0.000	1.000
DIVORCED	0.346	0.000	0.000	0.139	0.000	0.000	1.000
SMOKER	0.440	0.000	0.000	0.263	0.000	1.000	1.000
DISABLED	0.211	0.000	0.000	0.047	0.000	0.000	1.000
CHEST	0.354	0.000	0.000	0.147	0.000	0.000	1.000
HEART	0.410	0.000	0.000	0.213	0.000	0.000	1.000
EXTREMITIES	0.470	0.000	0.000	0.329	0.000	1.000	1.000
ELECTRICITY PRICE	1.110	7.145	8.061	8.900	8.749	9.509	11.598
GAS PRICE	0.356	1.729	1.813	2.057	1.888	2.161	2.867
ROOMS	0.344	0.693	1.386	1.459	1.386	1.609	2.197
CONDENSATION	0.308	0.000	0.000	0.106	0.000	0.000	1.000
ROT in WINDOWS	0.236	0.000	0.000	0.059	0.000	0.000	1.000
LEAKY ROOF	0.183	0.000	0.000	0.035	0.000	0.000	1.000
DAMP	0.253	0.000	0.000	0.069	0.000	0.000	1.000
END-TERACED HOUSE	0.281	0.000	0.000	0.086	0.000	0.000	1.000
SEMI-DETACHED HOUSE	0.475	0.000	0.000	0.345	0.000	1.000	1.000
TERACED HOUSE	0.404	0.000	0.000	0.205	0.000	0.000	1.000
FLAT	0.339	0.000	0.000	0.133	0.000	0.000	1.000
HOUSE	0.415	0.000	0.000	0.222	0.000	0.000	1.000

cities in the UK. This data thus captures regional differences in energy market structures as well as developments over time. All monetary values are converted into real terms, based on the CPI of the Office for National Statistics (ONS, 2013), base year is 2005. Table 2 provides summary statistics of the sample.

4. Results

We explore three specifications of our model in order to analyse the impacts of total energy spending as well as specific fuels on health satisfaction. Thus, we run regressions for three different endogenous variables in place of E_{it} in Eq (1): ENERGY, ELECTRICITY and GAS SPENDING.

Each of these potentially endogenous variables are explained using the same set of independent variables except for the prices. For overall energy spending we control for the gas price only, as gas and electricity prices are highly correlated in Great Britain[6]. The regression results are presented in Table 3. All estimations are based on the same sample, thus we explore only those households who have access to both fuels, electricity and gas. In all three specifications the testing procedure indicates that spending variables are not exogenous. The regression diagnostics at the bottom of the Table 3 suggest the instruments are relevant and appropriate.

Coefficients for all three specifications generally have the same signs but differ in magnitudes. For energy spending as well as for electricity and gas, coefficients are negative and significant. Electricity spending does have the strongest negative impact on health satisfaction. While gas is mainly used for heating and cooking, electricity is used for a range of technical appliances. Even though in our sample all households have access to both fuel, some households will use gas only for cooking and rely on electricity for heating. Also, poorer households usually have to use old and energy-inefficient technical appliances. If an appliance is broken, they tend to buy used ones which are not at the same technological standards as the newest product on the market (Boardman, 1991). Appliance usage for poorer households thus can be linked to higher than average electricity bills.

With respect to other drivers of health satisfaction, we find that health satisfaction is increasing in the average household age (AVERAGE AGE). The coefficient though is not significant in the third regression. In literature, it has been shown that over the life cycle overall happiness increases first until midlife and declines afterwards. It is argued that health satisfaction decreases beyond midlife (Easterlin, 2006). However, studies also show a u-shaped relationship between age and life satisfaction, indicating a lower life satisfaction at midlife (see for a discussion e.g. Dolan, Peasgood, and White, 2008). Since we consider the average household age rather than an individual's age, different effects might be mixed.

The coefficient of INCOME is negative and significant for all three specifications though quite small in magnitude. In happiness research it has been shown that income is relatively unimportant for happiness. Easterlin (2001) argues that an increase in income also leads to an increase in aspirations and, as a consequence, overall subjective well-being does not change. Since in our study we explore health satisfaction as one domain of life, it might well be that overall life satisfaction

[6]This correlation is explained by an increase in the share of combined cycle gas turbines (CCGT) as the preferred generation technology by new entrants in the post liberalisation period in the UK (Newbery, 2005).

Table 3: Regression results[a] I

	(1)	(2)	(3)
ENERGY SPENDING	-0.4132**		
	(0.0149)		
ELECTRICITY SPENDING		-0.7951***	
		(< 0.0001)	
GAS SPENDING			-0.3578**
			(0.0195)
AVERAGE AGE	0.1593*	0.2189**	0.1341
	(0.0925)	(0.0268)	(0.1555)
INCOME	-0.0329*	-0.0348*	-0.0320*
	(0.0865)	(0.0774)	(0.0965)
HOUSEHOLD SIZE	0.1787**	0.3106***	0.1528**
	(0.0118)	(0.0001)	(0.0198)
MARRIED	0.1196*	0.1640**	0.1223*
	(0.0566)	(0.0108)	(0.0550)
WIDOWED	0.0104	0.0545	0.0083
	(0.9163)	(0.5940)	(0.9330)
DIVORCED	0.0503	0.0741	0.0567
	(0.5276)	(0.3616)	(0.4819)
SMOKER	0.0710**	0.0819**	0.0685*
	(0.0496)	(0.0282)	(0.0584)
DISABLED	-0.5827***	-0.6104***	-0.5805***
	(< 0.0001)	(< 0.0001)	(< 0.0001)
CHEST	-0.3138***	-0.3170***	-0.3120***
	(< 0.0001)	(< 0.0001)	(< 0.0001)
HEART	-0.2879***	-0.2779***	-0.2907***
	(< 0.0001)	(< 0.0001)	(< 0.0001)
EXTREMITIES	-0.3353***	-0.3321***	-0.3374***
	(< 0.0001)	(< 0.0001)	(< 0.0001)
TREND	-0.1868***	-0.2522***	-0.1798***
	(< 0.0001)	(< 0.0001)	(< 0.0001)
TREND2	0.0065***	0.0093***	0.0063***
	(0.0001)	(< 0.0001)	(0.0002)
IV not rel. (p-val)[b]	< 0.0001	< 0.0001	< 0.0001
Sargan (p-val)[c]	0.5319	0.3274	0.4937
Cases	32,000	32,000	32,000

*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level;
[a] The dependent variable is health satisfaction ranging from 1 (dissatisfied) to 7 (satisfied);
[b] The null hypothesis is that the instruments are not relevant;
[c] The null hypothesis is that the model is overidentified.

slightly increases in income. However, a higher income might be linked to higher workloads and less time to recover thus leading to lower health satisfaction.

Health satisfaction increases in household size. If households consist of more than one person this implies individuals are interacting and socialising with others and most of them will be family members. In general, the possibility of interacting with family members is supposed to increase overall life satisfaction (e.g. Lelkes, 2006). With respect to health satisfaction, medical research e.g. has shown that feeling lonely can increase the occurrence of certain diseases such as dementia[7]. If the head of household is married (MARRIED) its health satisfaction is significantly higher in comparison to those who have never been married. If the head of household's marital status is WIDOWED or DIVORCED this is not significantly different to singles in terms of impacts on health satisfaction. Explanations for this are that married people tend to be less lonely and their sexual behaviour can differ from other groups (e.g. Blanchflower and Oswald, 2004).

Our results indicate that health satisfaction tends to be significantly higher for smokers (SMOKER) even though smoking is an adverse health behaviour. Smoking might be linked to lower aspirations and thus to an overestimation of health satisfaction. If an individual is disabled (DISABLED) its health satisfaction is significantly lower. As expected, any health problems an individual suffers from lead to significant lower health satisfaction. Coefficients for CHEST, HEART and EXTREMITIES are negative and highly significant.

The two trend variables TREND (linear) and TREND2 (trend squared) capture the development over time. As the coefficients indicate, health satisfaction first decreases and then increases again, over time. A possible explanation for this relation could be adaptation. As argued in Dolan and Kahnemann (2008), people's preferences transform over time and they adapt to some extent to their health state. I.e. even though the objective health status does not improve, adaptation leads to higher evaluation of health satisfaction over time.

In this study we focus on the subjective perception of the ability to keep homes adequately warm. Our results show that low level of thermal comfort impacts negatively on an individual's quality of life. To emphasis the difference between the (subjective) health satisfaction and objective health, we run the same regression using the objective health as the dependent variable all else equal. Regression result in Table 4 show that energy spending does not drive objective health.

[7]The article however also discusses the difference between feeling lonely and social isolation (e.g. Holwerda, Deeg, Beekman, Tilburg, Stek, Jonker, and Schoevers, 2012).

Table 4: Regression results[a] II

	(1)	(2)	(3)
ENERGY SPENDING	-0.0250		
	(0.8002)		
ELECTRICITY SPENDING		0.0502	
		(0.6390)	
GAS SPENDING			-0.0507
			(0.5690)
AVERAGE AGE	-0.0672	-0.0739	-0.0687
	(0.2235)	(0.1876)	(0.2106)
INCOME	0.0047	0.0046	0.0051
	(0.6715)	(0.6811)	(0.6509)
HOUSEHOLD SIZE	-0.0167	-0.0388	-0.0113
	(0.6866)	(0.3951)	(0.7674)
MARRIED	-0.0327	-0.0429	-0.0275
	(0.3702)	(0.2389)	(0.4577)
WIDOWED	-0.0208	-0.0292	-0.0173
	(0.7189)	(0.6145)	(0.7638)
DIVORCED	-0.0235	-0.0306	-0.0189
	(0.6124)	(0.5057)	(0.6877)
SMOKER	-0.0514**	-0.0531**	-0.0510**
	(0.0148)	(0.0121)	(0.0153)
DISABLED	0.3684***	0.3724***	0.3674***
	(< 0.0001)	(< 0.0001)	(< 0.0001)
CHEST	0.2521***	0.2520***	0.2525***
	(< 0.0001)	(< 0.0001)	(< 0.0001)
HEART	0.2485***	0.2473***	0.2485***
	(< 0.0001)	(< 0.0001)	(< 0.0001)
EXTREMITIES	0.2149***	0.2148***	0.2145***
	(< 0.0001)	(< 0.0001)	(< 0.0001)
TREND	0.0216	0.0355	0.0162
	(0.3440)	(0.1271)	(0.4626)
TREND SQUARED	-0.0006	-0.0012	-0.0003
	(0.5754)	(0.2377)	(0.7560)
IV not rel. (p-val)[b]	< 0.0001	< 0.0001	< 0.0001
Sargan (p-val)[c]	0.1811	0.1916	0.1941
Cases	31,994	31,994	31,994

*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level;
[a] The dependent variable is objective health ranging from 1 (excellent) to 5 (very poor);
[b] The null hypothesis is that the instruments are not relevant;
[c] The null hypothesis is that the model is overidentified.

5. Conclusions

The energy market developments foresee nothing but the increasing tendency of the energy spendings for households. While this hits the material status directly, which is the results of deprivation of households of portion of their income, the more subtle, intangible effects are not well documented. In this study, we set up a theoretical model of interconnectedness of energy spending and subjective health. We then use the representative panel of British households data to test the conclusions of the model. The empirical analysis suggests that higher energy, electricity and gas spending decrease health satisfaction, and thus reduce overall subjective well-being.

The finding for Great Britain though is an important finding for decision makers as it shows that individuals in a constrained situation do not only suffer from material problems but in addition suffer from a lower quality of life. It becomes clear that improving housing conditions as well as guaranteeing affordable warmth is also important in terms of increasing the overall quality of life of people. Ignoring these issues will strongly add to the discontent of life of individuals.

References

Adams, P., M. Hurd, D. McFadden, A. Merrill, and T. Ribeiro (2003): "Healthy, Wealthy and Wise? Tests for Direct Causal Paths between Health and Socioeconomic Status.," *Journal of Econometrics*, 112(5), 3–56.

Aylin, P., S. Morris, J. Wakefield, A. Grossinho, L. Jarup, and P. Elliott (2001): "Temperature, Housing, Deprivation and their Relationship to Excess Winter Mortality in Great Britain, 1986-1996," *International Journal of Epidemiology*, 30, 1100–1108.

Blanchflower, D., and A. Oswald (2004): "Money, Sex and Happiness: An Empirical Study," *Scandinavian Journal of Economics*, 106(3), 393–415.

BMJ (2008): "Effects of Improved Home Heating on Asthma in Community Dwelling Children: A Randomised Controlled Trial," *BMJ 337 a1411, doi 10.1136/bmj.a1411*.

Boardman, B. (1991): *Fuel Poverty: From Cold Homes to Affordable Warmth*. London: Belhaven Press.

Brounen, D., N. Kok, and J. Quigley (2012): "Residential Energy Use and Conservation: Economics and Demographics," *European Economic Review*, 56(5), 931–945.

Case, A., D. Lubotsky, and C. Paxson (2002): "Economic Status and Health in Childhood: The Origins of the Gradient," *American Economic Review*, 92(5), 1308–1334.

Contoyannis, P., and A. Jones (2004): "Socio-economic Status, Health and Lifestyle," *Journal of Health Economics*, 23, 965–995.

DECC (2013): "Average annual domestic electricity bills for selected towns and cities in the UK and average unit costs (QEP 2.2.3) and Average annual domestic gas bills for selected towns and cities in the UK and average unit costs (QEP 2.3.3)," `http://www.decc.gov.uk`.

Dolan, P., and D. Kahnemann (2008): "Interpretations of Utility and their Implications for the Valuation of Health," *Economic Journal*, 118, 215–234.

Dolan, P., T. Peasgood, and M. White (2008): "Do We Really Know What Makes Us Happy? A Review of the Economic Literature on the Factors Associated with Subjective Well-Being," *Journal of Economic Psychology*, 29, 94–122.

Easterlin, R. (2001): "Income and Happiness: Towards a Unified Theory," *Economic Journal*, 111, 465–484.

——— (2006): "Life Cyce Happiness and its Sources: Intersections of Psycology, Economics, and Demography," *Journal of Economic Psychology*, 27, 463–482.

Ferrer-i Carbonell, A., and P. Frijters (2004): "How Important is Methodology for the Determinants of Happiness," *Economic Journal*, 114, 641–659.

Greene, W. (2012): *Econometric Analysis*. Harlow: Pearson Education Limited, Seventh Edition. International Edition.

Holwerda, T., D. Deeg, A. Beekman, T. Tilburg, M. Stek, C. Jonker, and R. Schoevers (2012): "Feelings of Loneliness, but not Social Isolation Predict Dementia Onset: Results from the Amsterdam Study of the Elderly (AMSTEL)," *Journal of Neurology, Neurosurgery & Psychiatry*, 0, 1–8.

Lelkes, O. (2006): "Knowing What is Good for You. Empirical Analysis of Personal Preferences and the "Objective Good"," *Journal of Socio-Economics*, 35, 285–307.

Meier, H. (2010): *Health Satisfaction and Energy Spending*Cambridge Working Papers in Economics, CWPE 1053 and Electricity Policy Research Group Working Paper EPRG 1028, Faculty of Economics, University of Cambridge.

Newbery, D. (2005): "European Electricity Liberalisation," *Energy Journal*, 26, Special Issue, edited by David Newbery.

ONS (2013): "Consumer Price Index," `http://www.statistics.gov.uk`.

Somerville, M., I. MacKenzie, P. Owen, and D. Miles (2000): "Housing and Health: Does Installing Heating in their Homes Improve the Health of Children with Asthma?," *Public Health*, 114, 34–439.

Van Praag, B., and A. Ferrer-i Carbonell (2008): *Happiness Quantified: A Satisfaction Calculus Approach*. New York: Oxford University Press, Revised Edition.