

Health Satisfaction and Energy Spending

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Abstract

This study explores the link between energy spending and health satisfaction. We aim to show that energy spending is a driver of health satisfaction and therefore of the overall quality of life of individuals. This has important implications for policy makers especially in the context of fuel poor and low-income households. The analysis tests the hypothesis that health satisfaction decreases with increasing energy spending per room. Households with high energy spending tend to live in inefficiently insulated homes that are not heated adequately. We use a British panel household survey dataset with more than 60,000 observations covering the period 1997 to 2007. We apply a fixed effects econometric model which enables us to take unobservable heterogeneity between households into account.

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Health satisfaction, energy spending

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1. Introduction

This study aims at exploring the link between health satisfaction and energy spending. The intuition of this link is twofold: higher energy spending can increase health satisfaction as it enables households to adequately heat their homes and to sustain a certain level of comfort if, for example, energy prices rise. This has direct impacts on health and therefore on health satisfaction. But on the contrary, higher energy spending could indicate lower health satisfaction as higher energy spending might be induced by making up for inefficiently insulated and therefore inadequately heated homes without higher comfort. Also, an increase in energy spending might cause substitution effects by forcing households to reduce consumption of other goods like healthy food that have an impact on health, as well. Thus, higher energy spending might also have additional indirect effects causing lower health and health satisfaction levels. In this study, we explore energy spending as a determinant of health satisfaction.

This link has not been investigated in literature until now. We focus on the direct link between energy spending and health satisfaction and control for impacts of other determinants such as access to gas, age, income, and satisfaction levels in other domains of life such as social life or leisure. Indirect effects are assumed to be implicitly covered by the use of these control variables. Altogether, we focus on non-medical drivers of health satisfaction and therefore, illnesses or medical treatment are not explicitly taken into account.

Energy needs are mainly discussed in the context with energy affordability. Rising energy prices and the realization of climate change objectives will have impacts on energy usage and spending of households. At least for some households it will for example be more difficult to warm their homes adequately.

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These impacts should not be underestimated as they affect several domains of life simultaneously. In particular the health situation of household members might worsen if for example homes are not adequately heated.

The proceeding is as follows: First we will give an overview of the relevant literature, and then introduce the methodology used in our analysis. The fourth section describes the dataset in detail followed by the empirical approach and the results in the fifth section. The sixth section concludes.

2. Literature

Objective health and health satisfaction are part of the overall quality of life of household members. Quality of life or subjective well being of individuals is affected by satisfaction levels in different domains of life. A large range of different domains are discussed in literature. The majority regards health as one of the predominant domains (Cummins, 1996) and there is a large literature on determinants of health such as aging and income (f. e. Hsieh, 2005; Deaton, 2008). Comparing the importance of different domains-of-life on overall quality of life, Hsieh (2005) argues that health is highly relevant, but the relative importance of health decreases in age. Deaton (2008) explores the Gallup World Poll and investigates health satisfaction in 132 countries. His findings show that health satisfaction tends to be higher in high-income countries and health satisfaction decreases in age. For richer countries like the United States he shows that individuals aged 50-59 are less satisfied than younger and older individuals. However, if and to what extent energy spending affects health satisfaction has not been investigated, so far.

There is medical evidence that housing conditions related to heating have impacts on health. For example, several studies explore impacts of housing conditions on respiratory illnesses of children as these are common diseases of childhood (Somerville, et al. 2000, Butland et al., 1997, Ross et al. 1990 and Yarnell and Leger, 1977). In particular the installation of heating and its impact on school children with asthma living in damp houses in Cornwall was investigated. After heating was installed, frequency of all respiratory symptoms like cough or wheeze reduced significantly (Somerville, et al., 2000). The resolution of excess winter mortality has been explored in the context of temperature and housing. Aylin et al. (2001) find a significant relationship between the lack of central heating and excess winter mortality for Great Britain between 1986 and 1996. The study of Keating et al. (1989) for England and Wales states that between 1964 and 1984 central heating installation of households increased by up to 69%. At the same time, excess winter mortality caused by respiratory diseases decreased by 69%. But deaths from diseases like coronary or cerebrovascular did not decline due to the installation of central

heating. For the Netherlands, the decline in excess winter mortality could only be explained to a small degree by installation of central heating. It is argued that factors like decrease of jobs in agriculture, clothing improvement, working conditions or transport play an important role in mortality reduction, as well (Kunst, et al., 1990).

Even though it cannot be said that housing build to modern standards contributes to better health *per se*², the literature³ regards housing as a driver of health. Inadequate housing is not only a driver of fuel poverty (Roberts, 2008) but can lead to costs due to illnesses that are not covered by the market and only contribute to higher medical insurances (Jacobs et al., 2009). In addition, it is shown that improved housing due to energy efficiency measures contribute to mental health gains (Thomson, et al., 2003).

We use the British Household Panel Survey (BHPS). This large panel dataset aims at improving the knowledge about social and economic change of individuals and households in Great Britain and the whole United Kingdom. It provides data on for example household organisation, the work and education situation of individuals, income levels, and wealth. In addition, information on individual's subjective satisfaction levels in different domains of life, including health is given, as well as energy spending levels on different fuels. The panel structure allows us to explore the development of an individual's health satisfaction over time and in particular taking unobserved heterogeneity of individuals into account. The BHPS has been used for several studies of life satisfaction and domains of life satisfaction analyses. For example, Becchetti et al. (2008) analyse the link between money and happiness and find that more income does not lead to an increase in happiness, *per se*. Powdthavee (2009) shows that married people reach higher levels of happiness if their partner's happiness increases. Van Praag and Ferrer-i-Carbonell conducted a cost-benefit analysis, also using the BHPS and mainly focused on medical aspects of health satisfaction.

3. Methodology

We analyse data of an individual's perceived health situation as provided by the British Household Panel Survey (BHPS). We hypothesize that health satisfaction decreases in energy spending. It is anticipated that negative impacts of energy spending dominate positive ones such as the benefits of an increased level of warmth. Thus health satisfaction will be lower for higher energy spending levels. We control for the impact of energy spending per number of rooms in a home.

² See for an example Yarnell et al., 1977. The study shows that lung function of children in Wales in old housing was best in traditional valley housing. This is mainly explained by the influence of other factors such as smoking of parents. Apparently parents in traditional valley housing smoked comparably less.

³ See discussion above.

An increase in energy spending will lead *ceteris paribus* to a lower household budget. This implies that less money can be spent on other goods that are drivers of health satisfaction. As the consumption of these goods (for example healthy food) declines, health satisfaction can decrease. In addition, accessibility of gas can lead to differences in heating since households have to use electricity or oil for heating instead and might end up paying more in order to sustain a certain level of warmth. Accessibility to gas might have implications for heating and thus for health satisfaction. We therefore use a dummy variable for gas access. Since health satisfaction is affected by other determinants, we also control for income, age as well as satisfaction levels in other domains of life.

Two basic models are used for panel data analyses: fixed effects and random effects models. They differ in the way they capture individual specific effects. While the random effects model treats these as random, the fixed effects model treats them as time invariant fixed effects. If individual specific effects are random, they are also independent from the observed characteristics (Arellano, 2003). A Hausman Test compares estimated coefficients of both models and hypothesizes that differences in the coefficients are not systematic. If this hypothesis is rejected it is recommended to use the fixed effects model because unobservable heterogeneity among individuals exists which explains the systematic differences in coefficients and unobservable characteristics are not independent from the observable ones (Hausman and Taylor, 1981).⁴

$$HS_{it} = \beta X_{it} + v_i \quad (1)$$

Using the fixed effects (FE) approach Health Satisfaction (HS) of an individual i at time t is given in equation (1).⁵ The vector of explanatory variables varying in time is X_{it} . All time invariant variables are captured within the fixed effects v_i .

Individual heterogeneity plays an important role in the analysis of subjective well-being and satisfaction levels in different domains of life. Components of individual heterogeneity are discussed as personality traits but could also reflect an individual's health and background (Boyce, 2010). In the context of health satisfaction, it is reasonable to assume that individual specific characteristics exist. These could for example reflect the objective health situation of an individual or an individual's general attitude and evaluation of its satisfaction. Both will have an impact on the subjective health situation of an individual. Within a fixed effects model time invariant individual specific characteristics are simply captured in the individual fixed effects (Boyce, 2010). Time invariant explanatory variables therefore cannot be distinguished from the fixed effects.

⁴ The estimates of the random effects approach are biased, as unobservable heterogeneity is correlated with the observable characteristics.

⁵ For a more detailed discussion about fixed effects approach, see for an example Jamasb and Meier, 2010.

4. Data

The data used is based on the British Household Panel Survey (BHPS). The data set is an unbalanced panel of more than 5,000 households, over a 17 year period from 1991 to 2007. As part of the survey approximately 10,000 individuals (within the 5,000 households) have been re-interviewed annually. The primary objective of the survey is to enhance understanding of social and economic change at individual and household level in Britain. Data on perceived satisfaction levels in different domains of life is available from 1996 with the exception of 2001. For example, individuals are asked how satisfied they are with their health. The ranking ranges from 1 (not satisfied) to 7 (very satisfied). These subjective measures enable us to analyse individuals' satisfaction levels as it is only the individuals who can give information on their subjective states. In this analysis we focus on the health satisfaction of the heads of household. We also use the variables of satisfaction levels of other domains of life at the level of a head of household.

Variables	Description
HEALTH	Indicates how dissatisfied/satisfied an individual is with its health situation, 1 (least satisfied) to 7 (highly satisfied).
ENERGY SPENDING	Annual household energy spending per room in 2005 prices.
NO GAS	Equal to 1 if household does not have any gas spending, zero otherwise.
INCOME	Average annual household income.
AGE	Average household age.
SOCIAL LIFE	Satisfaction with social life (range 1 to 7) weighted by health satisfaction level.
AMOUNT OF LEISURE TIME	Satisfaction with amount of leisure time (range 1 to 7) weighted by health satisfaction level.
USE OF LEISURE TIME	Satisfaction with use of leisure time (range 1 to 7) weighted by health satisfaction level.
FLAT/HOUSE	Satisfaction with house/flat (range 1 to 7) weighted by health satisfaction level.
TIME TREND	Linear time trend.

Table 1: Description of variables used

The survey contains data on annual households (energy) spending on different fuels. Here we use energy spending as the sum of gas, electricity and oil spending. The data on energy spending for any of the different fuels is missing

for 1996, thus in this study we use a sample of the BHPS covering the period 1997 to 2007 and exclude 2001. We divide the energy spending level by the number of rooms using this as an indicator of the size of a home.

Variables	Obs	Mean	Std. Dev	Min	Max
HEALTH	64,902	4.86	1.64	1	7
ENERGY SPENDING	64,902	171.10	88.96	0.24	2,419.65
NO GAS	64,902	0.22	0.42	0	1
INCOME	64,902	27,139	22,757	34.84	1,009,984
AGE	64,902	44.18	20.97	5.25	99
SOCIAL LIFE	64,902	1.16	0.84	0.14	7
AMOUNT OF LEISURE TIME	64,902	1.22	1.03	0.14	7
USE OF LEISURE TIME	64,902	1.18	0.88	0.14	7
FLAT/HOUSE	64,902	1.37	1.09	0.14	7
TIME TREND	64,902	12.29	3.15	7	17

Table 2: Summary Statistics

The dummy variable NO GAS is assumed to describe whether a household has access to gas or not. If a household does not have any gas spending it is here assumed to have no access to gas. A description of the variables used is given in Table 1. Table 2 provides summary statistics of the sample.

5. Empirical Approach and Results

We estimate health satisfaction using the fixed effects model and the above mentioned explanatory variables. The estimation equation is as follows:

FE	$HS_{it} = \beta_{ES}ES_{it} + \beta_{NG}NG_{it} + \beta_I Inc_{it} + \beta_A A_{it} + \beta_D DoL_{it} + \nu_i + \varepsilon_{it}$	(2)
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Where:

HS_{it} : Level of an individual's health satisfaction

ES_{it} : Annual household's energy spending (sum of gas, oil and electricity spending).

NG_{it} : No Access to gas (no gas spending).

Inc_{it} : Annual household's income.

Em_{it} : Employed, Self-employed.

A_{it} : Average annual household age.

DoL_{it} : Level of an individual's satisfaction with social life, amount and use of leisure time and with house/flat.

ν_i : Time invariant fixed effects (unobservable characteristics).

ε_{it} : Error term.

We use a log-linear functional form. All monetary values, i.e. income and energy spending, are adjusted to overall price developments using the Consumer Price Index CPI of the UK Office for National Statistics (ONS) with 2005=100 (ONS, 2009). The independent variables are the log of household annual income and energy spending in 2005 prices. Also, the log of average household age is used as an explanatory variable. The dummy variable for gas access, NG, is equal to one for no gas spending and zero otherwise. In addition, we use weighted logs of the other domains of life. For an example, social life satisfaction is divided by health satisfaction levels and then the log of this fraction is used as an explanatory variable. Thus social life satisfaction is weighted by the health satisfaction level. We assume that satisfaction levels interact and use weighted rather than absolute satisfaction levels. This enables us to interpret satisfaction levels in one domain of life relative to satisfaction levels in another domain of life. A further reason for using weighted instead of absolute satisfaction levels is that we intend to avoid heterogeneity among individual with regard to their perceived satisfaction levels. The reason for this is that individuals might translate their satisfaction levels differently in the reported satisfaction levels, something which might lead to an additional source of heterogeneity among individuals (Becchetti et al., 2008). Using the log of health satisfaction we assume that increasing health satisfaction at lower levels is more difficult than increasing health satisfaction at higher levels.

Estimation results of the FE model are provided in Table 3. The Hausman test tests the H_0 hypothesis that differences in coefficients are not systematic i.e. if individual effects are independent from observable characteristics. Here the random effects approach is rejected, coefficients of the between estimator are not consistent. Results are as follows: $\chi^2(9)=1276.25$ and $\text{Prob}>\chi^2=0$, thus the H_0 and therefore random effects are rejected. (Arellano, 2003).

Dependent Variable: Log of health satisfaction

VARIABLES	Fixed effects estimation			
ENERGY SPENDING	-0.010***	(-4.89)		
NO GAS	-0.014**	(-2.99)		
INCOME	0.003*	(1.65)		
AGE	0.082***	(10.35)		
SOCIAL LIFE	-0.168***	(-49.24)		
AMOUNT OF LEISURE TIME	-0.144***	(-45.34)		
USE OF LEISURE TIME	-0.118***	(-33.00)		
FLAT/HOUSE	-0.358***	(-133.07)		
TIME	-0.003***	(-7.91)		
Constant	1.465***	(43.55)		
Observations	64,902			
Number of pid	13,784			
R-squared	0.63			
t-statistics in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Table 3: Estimation results

Health satisfaction is significantly lower if energy spending per room increases, as hypothesized (direct effect). The result suggests that households with higher energy spending per room live in inadequately heated homes with negative impacts on health satisfaction. No access to gas also leads to lower levels of health satisfaction. If households do not use gas (for heating) they might end up in not properly heated homes due to cost or technological reasons. These households might have to pay higher prices for electricity. The result might also imply the using fuels like oil or electricity for heating is not as efficient as using gas.

The income effect on health satisfaction is positive and shows that health satisfaction increases in income. Higher income enables households to consume more goods that are positively linked to health satisfaction. This result also suggests that the indirect effect of energy spending on health satisfaction is negative as higher energy spending decreases budget shares spent on other goods that are drivers of health satisfaction.

Other interesting findings, only in a subtle way linked to energy spending, show that health satisfaction increases in age. For a different model we found an inverted u-shaped relation between age and health satisfaction, indicating that health satisfaction first increases in age and then decreases again in higher ages. In contrast to this, Ferrer-i-Carbonell (2005) presents a u-shaped relation between the overall quality of life and age. But Hsieh (2005) empirically examines that older individuals evaluate satisfaction with health as relatively less important compared to other domains of life. Thus, our results are in line with the findings of Ferrer-i-Carbonell (2005) given that the relative importance of health decreases in age.

Our results show that health satisfaction decreases in relative satisfaction levels in other domains of life. The higher the relative satisfaction levels in other domains of life, the lower satisfaction with health will be. Higher relative satisfaction levels in other domains of life might imply that these domains of life are more important for individuals than health. One reason might be that individuals less satisfied with their health tend to evaluate satisfaction levels in other domains of life higher. These domains of life might increase in their relative importance.

6. Conclusions

Our study of health satisfaction explores different non-medical impact factors of health. We focus in particular on the effect of energy spending on health.

Our estimation results show that energy spending has negative impacts on health satisfaction. Health is an important domain of life and is a driver of overall life satisfaction. Thus higher energy spending does not only lead to low levels of health satisfaction but will also have negative impacts on overall quality of life.

Politicians aiming at improving health satisfaction of individuals should consider energy spending and energy affordability. At the same time, impacts of energy policy measures on health satisfaction of individuals should be considered. People having difficulties in warming their homes adequately will be less satisfied with their health. Lower levels of health satisfaction probably imply lower levels of the objective health situation of individuals and might lead to higher costs in the health sector. Our analysis shows that decision makers can approach health satisfaction through different channels. Impacts of fuel spending support need to be weighed against other instruments such as income support or home insulation improvement measures. Given that achieving climate change objectives can lead to higher energy bills for households this can result in lower health satisfaction of some of these. It is therefore necessary to undertake policy measures to protect the most vulnerable among these.

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