Age-differentiated QALI losses

van Praag, B.M.S.; Ferrer-i-Carbonell, A.

Publication date
2002

Document Version
Final published version

Published in
Discussion Paper

TI 2002-015/3
Tinbergen Institute Discussion Paper

Age-differentiated QALI Losses

*Bernard M.S. van Praag**
*Ada Ferrer-i-Carbonell***

** Faculty of Economics and Econometrics, University of Amsterdam, and Tinbergen Institute,*
*** SEO, Faculty of Economics and Econometrics, University of Amsterdam, and Tinbergen Institute,*

Tinbergen Institute
The Tinbergen Institute is the institute for economic research of the Erasmus Universiteit Rotterdam, Universiteit van Amsterdam and Vrije Universiteit Amsterdam.

Tinbergen Institute Amsterdam
Keizersgracht 482
1017 EG Amsterdam
The Netherlands
Tel.: +31.(0)20.5513500
Fax: +31.(0)20.5513555

Tinbergen Institute Rotterdam
Burg. Oudlaan 50
3062 PA Rotterdam
The Netherlands
Tel.: +31.(0)10.4088900
Fax: +31.(0)10.4089031

Age-differentiated QALY losses

Bernard M.S. van Praag* and Ada Ferrer-i-Carbonell**

21 November 2001

The authors would like to thank Peter Wakker for comments on an earlier draft. The responsibility for this paper is ours.

*Contact Author: Faculty of Economics and Econometrics, University of Amsterdam,
Roetersstraat 11, 1018 WB Amsterdam, the Netherlands.
The author is also affiliated at the Tinbergen Institute, the Netherlands.
E-mail: bvpraag@fee.uva.nl Phone: 31- 20 - 525 60 18/15 Fax: 31 - 20- 525 60 13

** Faculty of Economics and Econometrics and SEO Amsterdam Economics, University of Amsterdam, the Netherlands. The author is also affiliated at the Tinbergen Institute, the Netherlands.

Age-differentiated QALY losses

Abstract

In this paper we evaluate the QALY loss, which may be assigned to the prevalence of specific chronic illnesses and physical handicaps. The analysis is based on an individual self-rating health satisfaction question asked in the British Household Panel Survey data set. This question provides a natural cardinalization of health utility. Our method is a refinement of the method introduced by Cutler and Richardson (1997). We extend their approach in two directions. First, the health utility loss caused by a specific illness is allowed to have a different impact on individuals depending on their age. The empirical analysis shows that there are indeed significant age effects. The second extension deals with the cardinalization procedure chosen by Cutler and Richardson. They implicitly assume a linear effect of underlying explanatory variables on the evaluation of health. Instead, we suggest a more natural cardinalization, which does not exclude non-linearities.

Keywords: Chronic Illnesses, Health Satisfaction, QALY loss, Subjective Health.

JEL classification: I10, I12.

1. Introduction

This paper deals with the assessment of health losses due to a chronic illness or a physical impairment. Such losses are frequently measured in terms of Quality Adjusted Life Years (QALY). The QALY is a well-known concept that measures the average health quality during one year on a 0 to 1- scale (for surveys see Torrance, 1986, Dolan, 2000, and Woloshin *et al.*, 2001).

There is no uniformity on how health quality or utility should be measured. It is assumed that a health status h is evaluated by a cardinal utility function $U(h)$, which is scaled between 0 and 1, Usually perfect health is evaluated by 1 and the state of death by 0. If there are two health statuses h_1 and h_2, the difference $U(h_1) – U(h_2)$ is the QALY difference per year. There are various methods to evaluate health: expert rating, individual self-rating of own situation (for instance by means of a Visual Analog Scale(VAS)), standard gamble (SG), and time-trade-off (TTO)(see Dolan, 2000, and Torrance, 1986). In the first approach, the health of an individual is evaluated by experts, such as medical doctors. In the second approach, individuals themselves are asked to rate their own health status on a discrete ladder scale. In the SG - approach respondents are offered a (hypothetical) choice between their present health situation and a treatment with two possible outcomes associated with two probabilities. According to the TTO - method, patients have to make a choice between the present health status for T years or a hypothetical status of perfect health for (T-K) years.

The four methods yield different outcomes. The first method, although very frequently used (see Cutler and Richardson, 1997), suffers from the weakness that without an accepted protocol, various experts may use different utility functions. The SG- and the TTO- methods are based on hypothetical choices. Cutler and Richardson (1997, p.251) observe that "an obvious difficulty with the survey approach is the speculative nature of the question. People who are not paralyzed are likely to have little sense about what life with paralysis would be like. Assigning a

QALY weight to a condition one has never had is necessarily perilous”. Moreover, there is an indication that individuals may have more or less difficulty in answering these questions. Woloshin *et al*. (2001) give evidence that the ability to respond to SG and TTO questions depends, among others, on the level of numeracy of the respondent.

A more fundamental problem is the well–known fact that individuals adapt to their situation (see, for example, Ubel *et al.*, 2001). Therefore, the health utility function is partly determined by the individual’s own health status as every individual evaluates a health status with *reference* to his own situation. Say we have two individuals *A* and *B* with health status h_A and h_B, respectively. Individual *A* evaluates a health status *h* by $U(h;h_A)$ and *B* by $U(h;h_B)$. In that case, the QALY differences $U(h_A;h_A)-U(h_B;h_A)$ and $U(h_A;h_B)-U(h_B;h_B)$ are not necessarily equal. Let h_A stand for the situation of perfect health and h_B for the status of a chronic disease, then we may find the situation that the health loss caused by the illness is differently evaluated by patients than by healthy persons. Both assessments differ because the individual has to evaluate a real situation (his own) *and* a hypothetical one. An evident solution is to consider the difference $U(h_A;h_A)-U(h_B;h_B)$ or the utility function $U(h)\overset{D}{=}U(h;h)$. Such a function can only be constructed by collecting self – ratings from different persons with different health status, each evaluating only his own health situation.

It is this way which was chosen by Cutler and Richardson (1997) and which will also be our point of departure. We will refer to their paper by CR . Their paper evaluates health utility or QALY changes by means of individual self-ratings of own health, namely individual responses to a Health Satisfaction question. We will critically consider their method and suggest some improvements in two ways. First, the CR – specification, in accordance with most of the literature, does not account for the possibility that the effect of a chronic disease on the individual’s health satisfaction may depend on the age of the patient. Our specification leaves room for this possibility by introducing disease- specific age effects. Second, we introduce a new cardinalization to link individual responses to health utility. This cardinalization uses more of the available information than CR do. We will illustrate our points by empirical evidence derived from an analysis of the British Household Panel Survey (BHPS) data set.

Health satisfaction questions have been used before to measure individual health utility, for example by Bound *et al*., (1999), Cutler and Richardson (1997, 1998), Groot (2000), and Kerkhofs and Lindeboom (1995). We quote Cutler and Richardson (1997, p.252) who state: "this method is preferable to the others in the literature because it is straightforward for people to answer, it is based on individual, not expert opinion, and it has been conducted over time so we can see how QALY weights vary".

The paper is structured as follows. Section 2 presents the model. Section 3 describes the data and introduces the estimation results for the Health Satisfaction equation. Section 4 discusses the evaluation of QALY changes and compares them with the CR method. Next, it shows the results of those alternatives. Section 5 concludes.

2 The model

Health quality or utility is operationalized by means of the following health satisfaction question

How dissatisfied or satisfied are you with your health?

In the data set at hand, individuals are asked to give a categorical answer from 1 to 7, where 1 stands for 'not satisfied at all', and 7 for 'completely satisfied'. We call the answer to this question the individual's subjective Health Satisfaction (*HS*). Health satisfaction *HS* is the observed discrete-valued counterpart of an individual health utility index *H*, which is not continuously observable. In order to identify a cardinal health utility function from a health satisfaction question, we need to make some additional cardinalization assumptions. Evidently, the cardinalization introduces an element of arbitrariness[1]. Nevertheless, this is the only way to proceed if we wish to assess health utility or QALY changes. Section 4 discusses the cardinalization procedure in detail.

We assume that there is a function $H = H(h, x)$ and a partition $\{(m_{i-1}, m_i)\}_{i=1}^{7}$ with $m_0 = -\infty$ and $m_7 = +\infty$, such that $H \in (m_{i-1}, m_i)$ if *HS =i (i=1,…,7)*. We assume that *H* depends on the objective health status *h* and on a vector of individual characteristics *x*. We specify the *H* – function as

$$H_{nt} = c_t + b' x_{nt} + g' h_{nt} + V \bar{x}_n + e_{nt} + u_n \qquad (1)$$

Equation (1) is estimated by applying an Ordered Probit model on *HS*, taking into account the panel character of the data set. The subscripts *n* and *t* stand for individual *n* and time *t*, respectively. The vector x_{nt} consists of various explanatory objective variables such as income, education, and age. The vector h_{nt}, representing objective health, is a vector of 13 dummy variables corresponding to the 13 different illnesses observed in the sample. The j^{th} component equals one if the respondent suffers from the illness *j*, and equals zero otherwise. The error term e_{nt} is assumed to be N (0,1)-distributed as standard in ordered probit analysis. We allow for individual random effects u_n, which are constant across time but differ across individuals. We also include fix time effects c_t. Furthermore, we incorporate some of the explanatory variables (x_{nt}) not only as their yearly value but also as the average over the three years ($\bar{x}_n$). Mundlak (1978) proposed the same specification, where he argued that the mean of *x* will 'pick up' the

[1] We remind the reader to the problem of the definition of physical measurement units (see also Feynman, 1965). Temperature, for instance , can be defined by degrees in Celsius, but it is equally defensible to take any monotonic transform of temperature in Celsius. It is just a matter of scientific convention that temperature is measured by a thermometer and the results expressed in terms of Celsius. In a similar way we can and do assume a convention of how QALY's are measured in practice.

correlation between the observed individual characteristics (x_{nt}) and the individual unobservable random-effects (u_n). As regards content, an alternative explanation lies at hand. As explained in Van Praag et al. (2000), we can write

$$bx_{nt} + V\overline{x}_n = b(x_{nt} - \overline{x_n}) + (b + V)\overline{x_n} \tag{2}$$

The deviation from the mean, i.e. $(x - \overline{x})$, represents the effect of an incidental change from the mean, while the term $\overline{x}$ gives the long- term effect in the steady state. We call the first term the *shock* effect and the second the *level* effect. For income, this distinction yields the permanent and transitory income concepts as introduced by Friedman (1957). The two interpretations do not compete but are complementary. The estimation procedure distinguishes between shock and level effects in order to get better estimates of the chronic health effects.

After estimating Equation (1) by ordered probit, the expected value of *H* given the values of *x* and *h* can be found as $\hat{H}_{nt} = E(H_{nt} / x_{nt}, h_{nt})$. This estimation is comparable to that of Cutler and Richardson (1997) and of Groot (2000), the last applies the same method on one wave of the BHPS. Our specification, however, introduces the possibility that the impact of diseases on health satisfaction may depend on age as well. For that, some interaction terms between illnesses and age are included in Equation (1). Additionally, it involves more explanatory variables and it explores the panel character of the data set.

3. Data and estimation results

3.1. The data

For the empirical analysis, we make use of the British Household Panel Survey (BHPS). The BHPS is a comprehensive household survey covering about 10,000 individuals belonging to more than 5,000 British households. The BHPS is described by Taylor et al. (1999). We consider waves six to eight corresponding to 1996, 1997 and 1998, respectively. The reason for this restriction is that the health satisfaction question is only asked after wave 5. The survey includes a catalogue of various illnesses and physical handicaps, where the respondents have to answer whether they suffer from it or not. There is also a host of socio-economic and demographic variables referring to the individual and the household, e.g. age, children, education, and household income.

3.2 Estimation

Table 1 presents the estimation results for three different specifications of Equation (1). In the first specification health satisfaction (*HS*) is explained by various socio-economic and demographic variables, such as age, income, education, family size, and employment status. In the second specification dummies for illnesses are added. In the third specification interaction terms between the illnesses and age are added in order to make the illness effects age - specific. The last specification is, to our best knowledge, estimated for the first time.

Let us start with the simplest explanation where no information about the prevalence of diseases is used. The first two columns of Table 1 show the results. As expected, health falls monotonically with age (see also Deaton and Paxson, 1998). Health satisfaction is positively and significantly correlated with the mean of income, i.e., with permanent income. The positive correlation between income and health has been extensively discussed in the literature (see, e.g., Smith, 1994; Deaton and Paxson, 1998). Incidental fluctuations in income, i.e. the *shock* effects, do not seem to affect health. Males are slightly more satisfied with their health than females. The coefficient for education is negative and non-significant. The negative correlation between education and health satisfaction has also been found by Groot (2000) and Kerkhofs and Lindeboom (1995). We also notice that, health-wise, having children seems to be a mixed blessing. There seems to be an optimum number between one and two.

The results for the second specification are shown in the third and fourth columns of Table 1. The quadratic specification of age shows that age has now a positive effect on health from the age of 29.5 years onward. Thus, the inclusion of the dummies for illnesses changes the age coefficient from negative to positive. This may be explained by the fact that most illnesses are correlated with age. Thus, the variable *age* in the first specification is picking up the effect of the illnesses. Gender effects are now non-significant. Education becomes significant and is still negative. The children effect persists but becomes non-significant at the 5% level. The other coefficients do not change with the introduction of dummy diseases. The disease coefficients are all significant and negative. The values found are roughly comparable with Groot's (2000), who analyzed only one wave of the same data set. Using this, we can derive a hierarchy of diseases according to the magnitude of their effects on individual health satisfaction.

The results of the third specification are presented in the fifth and six columns of Table 1. By including interaction terms between illnesses and age, we can analyze whether the impact of the illness on health satisfaction is age-dependent. This may have several reasons. One, the objective degree of severity of an illness may vary with age. This is the case for 'chest and breath problems'. Two, even if the illness is becoming objectively more severe with age, the individual may subjectively perceive it differently. The reasons can be diverse: people may adapt to an illness; older individuals may require less from their body than young ones; and older individuals may get other disorders as well, such that their original illness becomes only one of several complaints. These reasons could be the explanation for the positive age coefficients found for 'difficulty in hearing', 'heart and blood problems', 'problems with the stomach, liver, and kidneys', 'diabetes', and 'anxiety, depression or bad nerves'. For some impediments and illnesses, we did not find a marked age-dependency and thus we did not include an interaction term with age. Notably, the dummy coefficient found for 'chest and breath problems' becomes non-significant when we include an interaction term with age. Figure 1 displays the age pattern for various illnesses, i.e. $d_j + d_j \ln age$. We see that health losses diminish with age except for the 'chest and breath problems'.

For all three specifications, we notice that the variances of the individual random effects are fairly large and represent about 50% of the total unobservable effects.

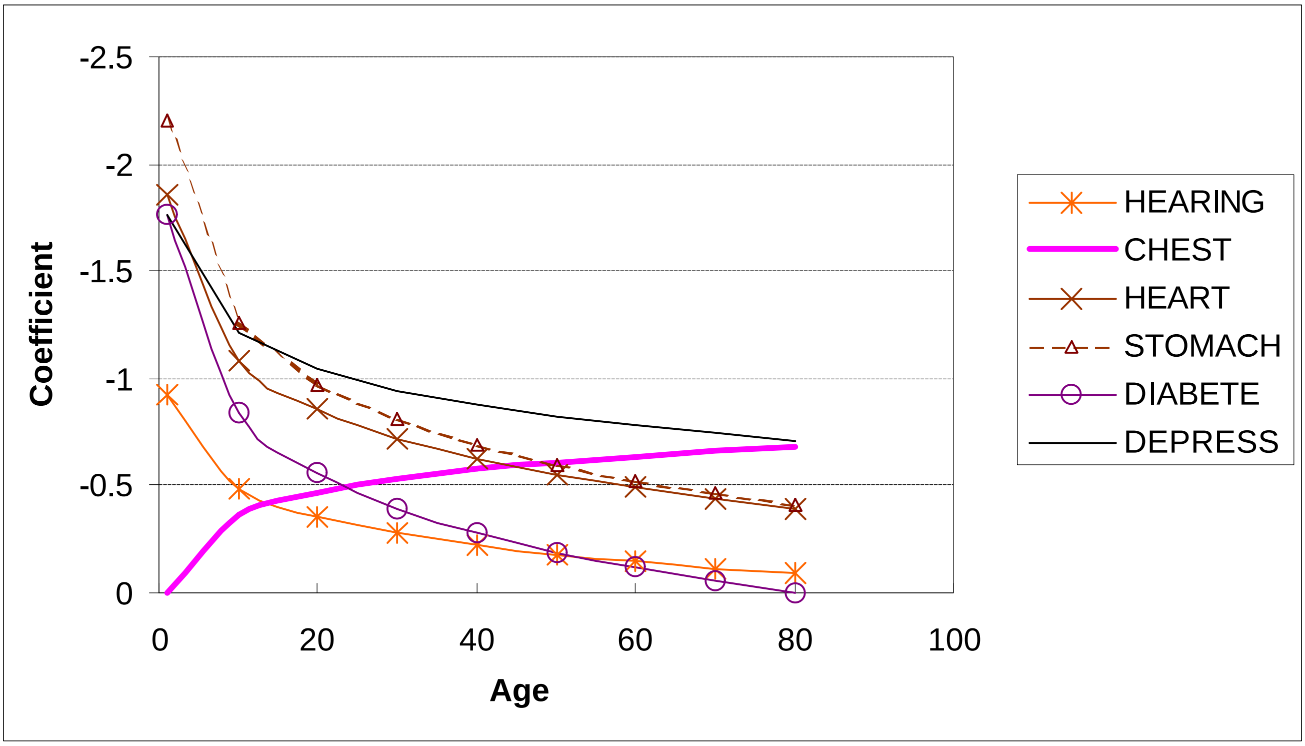

Figure 1: Age pattern of QALY weights for various illnesses and impediments

Table 1: Health Satisfaction Probit Equations

	Coeff.	*Std.Err.*	Coeff.	*Std.Err.*	Coeff.	*Std.Err.*
Intercept term	4.308	*4.671*	7.039	*9.022*	5.700	*7.149*
Time Fix Effect 1996, wave 6	-0.096	*-5.944*	-0.138	*-8.550*	-0.139	*-8.646*
Time Fix Effect 1997, wave 7	-0.038	*-2.403*	-0.057	*-3.654*	-0.057	*-3.659*
Ln (age)	-1.289	*-2.472*	-2.419	*-5.436*	-1.598	*-3.500*
Ln2 (age)	0.131	*1.829*	0.357	*5.807*	0.235	*3.714*
Minimum	*137.362*		*29.642*		*29.879*	
Ln (income last month)	-0.010	*-0.654*	-0.019	*-1.213*	-0.020	*-1.294*
Ln (children +1)	0.176	*2.005*	0.097	*1.163*	0.092	*1.101*
Ln2 (children +1)	-0.162	*-2.671*	-0.102	*-1.901*	-0.101	*-1.866*
Maximum	*1.726*		*1.605*		*1.578*	
Male	0.103	*3.812*	-0.011	*-0.463*	-0.012	*-0.522*
Ln (years Education)	-0.034	*-1.065*	-0.064	*-2.268*	-0.067	*-2.366*
Missing Education	-0.158	*-1.871*	-0.197	*-2.396*	-0.209	*-2.532*
Living together?	0.016	*0.565*	-0.015	*-0.586*	-0.013	*-0.537*
Arms, legs, hands, feet, back, or neck			-0.649	*-31.950*	-0.649	*-31.935*
Difficulty in seeing			-0.252	*-6.669*	-0.262	*-6.888*
Difficulty in hearing			-0.156	*-4.569*	-0.923	*-2.484*
Skin conditions/allergies			-0.138	*-4.704*	-0.142	*-4.809*
Chest/breathing problems			-0.583	*-21.987*		
Heart/blood problems			-0.511	*-19.100*	-1.853	*-5.314*
Stomach/liver/kidneys			-0.608	*-19.227*	-2.199	*-6.671*
Diabetes			-0.673	*-10.475*	-2.293	*-2.847*
Anxiety, depression or bad nerves			-0.852	*-28.138*	-1.760	*-5.906*
Alcohol or drug related problems			-0.948	*-6.754*	-0.889	*-6.327*
Epilepsy			-0.649	*-6.118*	-0.654	*-6.179*
Migraine or frequent headaches			-0.270	*-8.898*	-0.263	*-8.623*
Other health problems			-0.787	*-23.594*	-1.436	*-4.548*
Difficulty in hearing * ln(age)					0.190	*2.093*
Chest/breathing problems * ln(age)					-0.156	*-22.730*
Heart/blood problems * ln(age)					0.333	*3.908*
Stomach/liver/kidneys * ln(age)					0.409	*4.924*
Diabetes * ln(age)					0.401	*2.048*
Anxiety, depression or nerves * ln(age)					0.239	*3.104*
Others * ln(age)					0.167	*2.079*
Mean (Ln(income last month))	0.194	*7.928*	0.081	*3.579*	0.082	*3.620*
Mean (Ln(children +1))	0.128	*1.948*	0.090	*1.411*	0.091	*1.425*
m_2	0.523	*38.851*	0.543	*39.379*	0.543	*39.335*
m_3	1.210	*72.900*	1.253	*74.478*	1.254	*74.518*
m_4	1.923	*106.559*	1.981	*108.520*	1.984	*108.596*
m_5	2.794	*145.391*	2.855	*147.111*	2.859	*147.273*
m_6	4.050	*193.934*	4.085	*192.157*	4.090	*192.282*
σ (υ)(individual random effect)	1.264	*97.002*	0.994	*83.229*	0.992	*83.026*
Log Likelihood	-48702		-46719		-46685	
Number of individuals	12033		12033		12033	
Number of observations	29979		29979		29979	

* μ_1 is standardized at 0.

4. QALY losses

4.1 The cardinalization

The measurement of health satisfaction in health utility or QALYs requires a cardinalization that translates the utility index *H* to a cardinal [0,1] - scale. The cardinal health utility function is $U(h,x) = j\,(H(h,x))$. This clearly shows that the choice of the cardinalization boils down to the choice of a specific mapping *j (.)*. Just like in physics we have to define the measurement procedure in a way which yields handy mathematical relationships and which is not counter-intuitive. For instance, it would be possible to define temperature as the logarithm or the exponential of the number we find on the Celsius thermometer. However, it would yield a rather unfamiliar or awkward representation of the Gay –Lussac Law. Musical notes are generally defined by the number of oscillations per second. When we have two A's separated by one octave, the higher A has twice the number of oscillations as the lower A. For the perception of music octaves represent constant distances, which implies that hearing takes place on a log- scale where a difference of an octave stands for log(2). The definition of notes on the piano keyboard, where the octave interval has constant length is essentially logarithmic. The choice of the cardinalization is dictated by expediency and intuition. After its definition has become accepted, it gets emotional meaning by steady usage.

Actually, we think that respondents offer a cardinalization by their response behavior. Thus, their health utility is evaluated by 3 on a (1,7) – scale, if they say to evaluate their health situation by 3. We call this the *natural* cardinalization. Of course, it makes no essential difference, when we multiply all responses by a fixed factor, for instance, by 1/7 so as to get the answers on a (0,1)- scale, or when we add a constant to each utility.

Cutler and Richardson (1997) used the cardinalization

$$U = j\ (H) = 0 \qquad \text{if } H < m_1$$

$$U = j\ (H) = H/(m_6 - m_1) \qquad \text{if } m_1 < H < m_6$$

$$U = j\ (H) = 1 \qquad \text{if } H > m_6 \tag{3}$$

It postulates that the relationship between the estimated latent variable H and *U* or QALY is linear. See Figure 2 for a graphical presentation.

There are three aspects to this re-cardinalization that are bothersome. The first one is that in the CR-cardinalization the QALY loss due to a chronic disease is not conditioned by the other variables that also determine H , such as age, income, and family situation. This is not realistic. A chronic disease has a different impact on a child than on an old individual . Our second point may be illustrated as follows. In Equation (3) the categories have different lengths, proportional to ($\mu_{i+1} - \mu_i$). This is rather unnatural for a numerical scale. In the *natural* cardinalization , the categories 1 to 7 have the same step length. The third bothersome aspect of the cardinalization proposed by CR is that it can be shown that in the Ordered Probit – model (see, for example, Terza, 1987 p. 278) holds

$$N(m_i) - N(m_{i-1}) = p_i \ \ (i = 1,...,7) \tag{4}$$

where *N(.)* is the standard normal distribution function and the p_i are the sample frequencies. Hence, according to the CR - specification the sample frequencies determine the step lengths on the QALY or health utility scale.

It is therefore that we propose a continuous cardinalization, which conforms as much as possible to the respondent's natural cardinalization and assigns equal steps to the numbered categories. It is still a problem which value to assign to health differences (H_1-H_2) where both $H_1, H_2 \in (m_{i-1}, m_i)$. Here we follow the CR- cardinalization that health differences 'within' one category are proportional to (H_1-H_2). It is the best information we have as long as there is no refinement of the response categories. This leaves us with the problem of the 'tail ' categories as they have infinite length. Here we assign constant values of ½*1/7 and (6/7+ ½*1/7) for the left and right tail respectively. For we do know for the lowest category that the health utility of the lower left (*minus* infinity) bound is zero and that the upper-right bound m_1 corresponds to 1/7 (on a seven scale). For the highest category the reasoning is identical. This yields the following cardinalization

$$U = j\,(H) = \frac{0.5}{7} \qquad \text{if } H \le m_1$$

$$U = j\,(H) = \frac{(i+0.5)}{7} + \frac{(H - m_i)}{7(m_{i+1} - m_i)} \qquad \text{if } m_i < H \le m_{I+1} \qquad \text{for } i=2,\dots,6$$

$$U = j\,(H) = \frac{6.5}{7} \qquad \text{if } H \ge m_6 \qquad (5)$$

This cardinalization generalizes to any partition into *k* categories. It is this cardinalization of *H* that we will use in the following computations. The difference between both cardinalizations are displayed in Figure 2. The C-R method is represented by the dashed line and the other curve represents our cardinalization method.

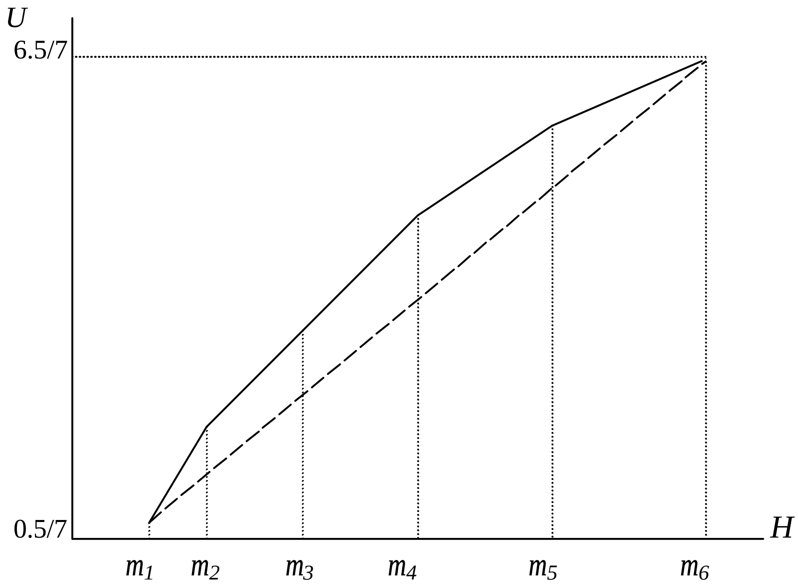

Figure 2. The relation between H and U approximated by a spline function and by linear interpolation

The *absolute* QALY or utility loss when moving from one health status 1 to another health status 2 is now defined as

$$\text{Absolute loss} = U(1) - U(2) \tag{6}$$

Similarly the *relative* QALY loss is defined as

$$\text{Relative loss} = \frac{U(1) - U(2)}{U(1)} \tag{7}$$

4.2 Estimates of QALY losses

Next, the absolute and relative QALY or health utility losses for all illnesses included in the BHPS for a male of 30 and for one of 60 are presented in Table 2. For these calculations, we use the third specification of Table 1 and Equations (4), (6), and (7). As a reference group[2] we take males in 1996, living in partnership, with an income of U.K. £1900 per month, two children, and 10 years of education. Table 2 also presents the QALY weights when we apply the CR approach to the second specification of Table 1.

Table 2 shows, for example, that an individual of 30 years old who suffers from diabetes has an absolute QALY loss of 0.135, while a man of 60 would have a loss of only 0.084. Table 2 shows that for all diseases except for 'chest and breath problems', the absolute and relative QALY losses are equal or larger for a 30 years old man than for a 60 years old man.

Table 2: QALY losses due to various diseases

Disease / Age	Absolute QALY Loss		Relative QALY Loss		QALY Weight
	30	60	30	60	CR approach
Average QALY level for healthy people	0.684	0.698			
Arms, legs, hands, feet, back, or neck	0.089	0.084	0.130	0.120	0.159
Difficulty in Seeing	0.173	0.173	0.253	0.248	0.062
Difficulty in Hearing	0.175	0.16	0.256	0.229	0.038
Skin conditions/allergies	0.159	0.159	0.232	0.228	0.034
Chest, breathing problems, asthma, bronchitis	0.07	0.082	0.102	0.117	0.143
Heart/blood problems or blood circulation problems	0.101	0.058	0.148	0.083	0.125
Stomach/liver/kidneys	0.115	0.063	0.168	0.090	0.149
Diabetes	0.135	0.084	0.197	0.120	0.165
Anxiety, depression or bad nerves	0.137	0.105	0.200	0.150	0.209
Alcohol or drug related problems	0.128	0.123	0.187	0.176	0.232
Epilepsy	0.09	0.085	0.132	0.122	0.159
Migraine or frequent headaches	0.173	0.173	0.253	0.248	0.066
Other health problems	0.125	0.1	0.183	0.143	0.193

[2] The sample mean in 1996 for income is U.K. £1834 per month and approximately 10 years of education.

The relative QALY loss for diabetes is 0.197 for a male of 30 years old, and 0.120 for one of 60 years old. The QALY weight for diabetes derived by the CR approach is 0.165.

Let us now look what are the average losses for the British population, as represented by the waves 6 to 8 in the BHPS, where we assume that every citizen suffers from one illness at most. Here, we calculate for all respondents their expected *H* and corresponding health utility *U*. Next, we compute the health utility for all the respondents under the ideal situation that all individuals would be healthy. We call the first measure the *actual* health utility and the second the *ideal* health utility. Then, we can define the population health utility or QALY *loss* as the difference between the actual and the ideal health utility level. In table 3, we present the averages of the actual health utility and health utility losses, compared to the ideal situation of 'no illness' for the total sample, for the sub - samples of males and females, and for three age brackets. The actual health utility for the whole population is about 0.75. The level falls with increasing age from 0.79 to 0.70. Females have a lower health utility than males. The average health utility or QALY loss, caused by the illnesses, including multiple prevalence, is about 0.08. Hence, the health utility is reduced by more than 10 %.

In the rest of the table we look at the health utility loss caused by having *one* illness. For each illness, we present 3 rows. The first row shows the actual health utility, the second the health utility or QALY loss, and the third the corresponding sample frequencies. We see that the most frequently found illness or impairment is problems with 'arms, legs, hands, feet, back, or neck', viz. for 27 % of the sample, followed by 'chest and breathing problems', and 'heart problems' and 'skin problems'. The surprisingly large percentage of respondents with 'arms, legs, hands, feet, back, or neck problems' may be caused by the fact that it is a broad impediment definition that includes very different degrees of severity, which can not be distinguished in the BHPS. The overall health utility loss due to arms problems is 0.023. However, if we restrict the loss to the actual sufferers it implies that the loss has to be multiplied for the sufferers by 1/0.27. It follows that the loss for sufferers is about 0.11. Similar calculations can be made for the other illnesses.

We can see in table 3 that the lower health utility for female respondents is especially due to the ‘arms, legs, hands, feet, back, or neck problems’, ‘Anxiety, depression or bad nerves’, and ‘migraine or frequent headaches’. This result is a combination of different weights and different prevalence of the illness among the sub-samples.

Table 3. Health utility averages and losses in the population.

		Total	Male	Female	<30	30-65	>65
Actual *U*		0.7514	0.7633	0.7412	0.7879	0.7543	0.7040
U loss		0.0847	0.0719	0.0956	0.0456	0.0799	0.1393
One Illness							
Arms	Actual *U*	0.8130	0.8145	0.8116	0.8250	0.8130	0.7995
	U Loss	0.0231	0.0207	0.0252	0.0084	0.0213	0.0437
	%Prevalence	27.32%	24.33%	29.87%	9.63%	24.71%	52.99%
Sight	Actual *U*	0.8346	0.8340	0.8352	0.8328	0.8333	0.8397
	U Loss	0.0015	0.0013	0.0016	0.0006	0.0009	0.0035
	%Prevalence	4.78%	4.17%	5.30%	2.13%	3.07%	11.59%
Hearing	Actual *U*	0.8347	0.8336	0.8356	0.8326	0.8331	0.8406
	U Loss	0.0014	0.0016	0.0012	0.0009	0.0012	0.0026
	%Prevalence	8.13%	9.26%	7.17%	2.26%	5.24%	21.22%
Chest	Actual *U*	0.8260	0.8255	0.8265	0.8255	0.8258	0.8271
	U Loss	0.0101	0.0097	0.0104	0.0079	0.0085	0.0161
	%Prevalence	13.44%	12.91%	13.89%	13.12%	11.20%	18.85%
Skin	Actual *U*	0.8341	0.8336	0.8344	0.8309	0.8323	0.8417
	U Loss	0.0020	0.0016	0.0024	0.0025	0.0020	0.0015
	%Prevalence	12.32%	9.78%	14.48%	15.25%	12.17%	9.38%
Heart	Actual *U*	0.8275	0.8274	0.8276	0.8309	0.8273	0.8243
	U Loss	0.0086	0.0078	0.0092	0.0025	0.0070	0.0190
	%Prevalence	14.18%	12.93%	15.24%	2.27%	9.72%	37.53%
Stomach	Actual *U*	0.8304	0.8301	0.8306	0.8297	0.8280	0.8364
	U Loss	0.0057	0.0051	0.0063	0.0038	0.0062	0.0068
	%Prevalence	7.34%	6.46%	8.09%	2.93%	7.14%	12.73%
Diabetes	Actual *U*	0.8339	0.8330	0.8347	0.8322	0.8325	0.8388
	U Loss	0.0022	0.0023	0.0022	0.0012	0.0017	0.0044
	%Prevalence	2.47%	2.52%	2.43%	0.78%	1.68%	6.12%
Depress	Actual *U*	0.8272	0.8294	0.8253	0.8271	0.8239	0.8349
	U Loss	0.0089	0.0058	0.0115	0.0063	0.0104	0.0083
	%Prevalence	7.50%	4.85%	9.75%	4.39%	8.59%	8.49%
Alcohol &Drugs	Actual *U*	0.8355	0.8344	0.8365	0.8327	0.8336	0.8430
	U Loss	0.0006	0.0009	0.0003	0.0007	0.0007	0.0002
	%Prevalence	0.45%	0.67%	0.27%	0.56%	0.52%	0.17%
Epilepsy	Actual *U*	0.8354	0.8346	0.8361	0.8326	0.8335	0.8428
	U Loss	0.0007	0.0006	0.0007	0.0008	0.0007	0.0004
	%Prevalence	0.76%	0.72%	0.80%	0.91%	0.82%	0.47%
Migraine	Actual *U*	0.8332	0.8337	0.8328	0.8306	0.8309	0.8412
	U Loss	0.0029	0.0015	0.0040	0.0028	0.0033	0.0020
	%Prevalence	9.41%	5.03%	13.14%	9.20%	10.83%	6.46%
Other	Actual *U*	0.8308	0.8316	0.8301	0.8304	0.8288	0.8358
	U Loss	0.0053	0.0037	0.0067	0.0030	0.0055	0.0074
	%Prevalence	4.95%	3.47%	6.20%	2.35%	4.94%	7.87%
Number of Observations		29979	13779	16200	7670	16669	5640

5. Conclusions

In this paper we consider which QALY or health utility losses may be assigned to various physical handicaps and illnesses. We use individual self-ratings of health, as provided by the Health Satisfaction question in the British Household Panel Survey. The method we use is a refinement of the one originally devised by Cutler and Richardson (1997). The novelties of the paper are two. First, we argue that the effect of an illness on health may vary with the age of the individual. Therefore, we introduce interaction terms between illnesses and age in the model. Indeed, we find considerable age effects. For instance, a 30 years old male suffering from diabetes appears to experience a QALY loss of 0.135, while this is only 0.084 if the male is 60 years old. It is obvious that this can be extended to other characteristics such as gender and job situation. The QALY or health utility losses differentiated by age have a clear implication for the cost-effectiveness analysis of therapies. In practice it implies that therapies on chronic diseases are more cost-effective for the demographic group with the higher QALY losses per year. This has an obvious ethical dimension.

Second, Cutler and Richardson chose a specific cardinalization procedure, which does not exhaust all available response information. Moreover, it implies a linear relationship between the explanatory variables and the responses on the Health Satisfaction question. We suggest a more natural cardinalization, which stays closer to the response behavior and which does not suffer from linearity restrictions. Moreover, it exhausts the response information.

We are aware of the fact that the operationalization of health utility remains a difficult methodological problem. There are several methods proposed and there is no hard methodological evidence that one is better than the other. The primordial question is a matter of taste depending on the following ‘criteria’: how does the index differentiate between health situations according to our intuition and to political relevance; is it easy to operationalize the index and does it lead to comparable and repeatable results; and what are the costs to implement the index on a large scale?

The results of this paper show, in our opinion, that the method described in this paper scores well on the above mentioned aspects. The method is operational to evaluate the health situations of populations and population subgroups and the impact of specific illnesses and handicaps. Other more problem - oriented surveys are needed to trace the effect of illnesses and possible therapies in more detail.

References

Cutler D, Richardson E., 1997. Measuring the health of the U.S. population. *Brooking Papers: Microeconomics*, p.217-271.

Deaton, A.S., and Paxson, C.H., 1998. Aging and Inequality in Income and Health. *American Economic Review*, 88: 248-253.

Dolan , P., 2000. The measurement of health-related quality of life. In: Culyer, A.J., Newhouse, J.P, (eds.). *Handbook of Health Economics*. V.1B. Elsevier, Amsterdam.

Feynman, R., 1965. *The character of physical law*. The M.I.T. Press, Cambridge, Massachusetts.

Friedman, M., 1957. *A theory of the consumption function*. Princeton University Press, NJ.

Groot W., 2000. Adaptation and scale of reference bias in self-assessments of quality of life. *Journal of Health Economics*, 19: 403-420.

Kerkhofs M, Lindeboom M. 1995. Subjective health measures and state dependent reporting errors. *Health Economics*, 4: 221-235.

Maddala, G.S., 1999. *Limited-dependent and qualitative variables in econometrics*. Cambridge University Press, Cambrdige, UK.

Mundlak, Y., 1978. On the Pooling of Time Series and Cross Section Data. *Econometrica*, 46: 69-85.

Praag, B.M.S. van, Frijters, P., and Ferrer-i-Carbonell, 2000. A structural model of well-being: with an application to German Data. Tinbergen Institute Discussion Paper TI 2000-053/3, the Netherlands.

Smith, J.P., 1999. Healthy bodies and thick wallets: the dual relation between health and economic status. *Journal of Economic Perspectives*, 13(2): 145-166.

Taylor, M.F. (ed). with J. Brice, N. Buck and E. Prentice-Lane, 1999. *British Household Panel Survey User Manual Volume A: Introduction, Technical Report and Appendices*. Colchester: University of Essex.

Terza, J. V., 1987. Estimating linear models with ordinal qualitative regressors. Journal of Econometrics, 34(3): 275-291.

Torrance, G.W., 1986. Measurement of health state utilities for economic appraisal. A review. *Journal of Health Economics,* 5: 1-30.

Ubel, P.A, Loewenstein, G. , Hershey J., Baron, J. , Mohr, T., Asch, D.A., and Jepson Ch., 2001. Do nonpatients underestimate the Quality of Life associated with chronic health conditions because of a focusing illusion? *Medical Decision Making*, 21: 190- 199.

Woloshin, S., Schwartz, L.M.S., Moncur, M., Gabriel, S., and Tosteson, A.N.A., 2001 Assessing Values for health: Numeracy matters. *Medical Decision Making*, 21: 380- 390.