

# ICAE

**Instituto Complutense de Análisis Económico**

UNIVERSIDAD COMPLUTENSE

FACULTAD DE ECONOMICAS

Campus de Somosaguas

28223 MADRID

Teléfono 91 394 26 11 - FAX 91 294 26 13

Internet: <http://www.ucm.es/info/icae/>

E-mail: [icaesec@ccee.ucm.es](mailto:icaesec@ccee.ucm.es)



49  
(9902)

## Documento de trabajo

**Ethical Dilemmas in Health Policy:  
More Evidence on Distributive Preferences**

Eva Rodríguez Mínguez

José Luís Pinto Prades

No. 9902

Junio 1999

# ICAE

**Instituto Complutense de Análisis Económico**

UNIVERSIDAD COMPLUTENSE

R. 67.214

## Ethical Dilemmas in Health Policy: More Evidence on Distributive Preferences\*

**Eva Rodríguez Míguez**  
Universidad Complutense de Madrid (ICAE)  
Universidad de Vigo  
Departamento de Economía Aplicada. 36310 Vigo  
e-mail: emiguez@uvigo.es

**José Luís Pinto Prades**  
Universidad Pompeu Fabra

1983360X  
MEE 5318404936  
27948663

### ABSTRACT

The QALY —quality adjusted life years— approach assumes that each additional QALY has the same social value. The implications of this approach regarding distributive equity have been criticised. In this paper we identify different distributive preferences held by society, examining which restrictions need to be imposed in the Social Welfare Function (SWF) in order that this function can represent the mentioned preferences. Furthermore, we propose a particular SWF that allows us to collect different degrees of aversion to inequality, depending on the QALY gains being analysed. The results of an experiment whose objective is to obtain a first empirical approach to the SWF are presented.

### RESUMEN

El modelo QALY —años de vida ajustados por calidad— considera que cada QALY adicional tiene el mismo valor social. Las implicaciones de este enfoque en cuanto a la equidad distributiva han sido muy criticadas. En este artículo se identifican diferentes preferencias distributivas presentes en la sociedad, identificando las propiedades que debe tener la Función de Bienestar Social (FBS) para éstas preferencias puedan ser representadas. Además, se propone una FBS concreta que permite incorporar diferentes grados de aversión a la desigualdad dependiendo del número de QALYs individuales obtenidos. También se muestran los resultados de un experimento cuyo objetivo es obtener una primera aproximación de la FBS.

JEL: D63, I10

\* The authors would like to thank Han Bleichrodt and Gregorio Serrano for their comments and suggestions. Any remaining errors are the authors' responsibility. José Luís Pinto acknowledges financial support from Dirección General de Enseñanza Superior, SEC 98--0296--C04--01. Eva Rodríguez acknowledges financial support from University Complutense of Madrid by a grant received while this study was conducted.

## 1 Introduction

Cost-effectiveness analysis is a methodology that facilitates social decision-making in the allocation of scarce resources. With respect to its application to the health care sector, an output measure is needed to compare the effects the different health care programs have on people's health. The QALY — quality-adjusted life year— has been proposed as an adequate measure since it combines quantity and quality of life into one single index. Given that the QALY approach is based on the Utility Theory (e.g., Torrance, 1976 and Pliskin et al., 1980), cost-effectiveness analysis is normally called cost-utility analysis when the effects are assessed in QALYs.

Calculating cost per QALY, it is possible to compare different health care programs in terms of efficiency. Following cost-utility analysis, the best allocation of health resources is that which maximises the community's health obtained from the unweighted sum of individual QALYs. In this way, each additional QALY is implicitly considered to have the same social value, independent of the characteristics of the patient and the number of QALYs received. We will refer to this unweighted sum as the aggregated QALY model (AQM) to distinguish it from the QALY model which focuses on getting individual QALYs, previous to the aggregation process.

Despite a few exceptions, such as the age of the patients, the egalitarian aspect of the AQM has a very high degree of social acceptance. However, not considering distributive effects incites greater controversy. Given that a QALY is always assigned the same social value, giving many QALYs to few people will have the same social value as giving few QALYs to many people, as long as the total number of QALYs given remains constant. Some empirical studies (e.g., Olsen, 1994, Johannesson and Gerdtham, 1996, Nord, 1996 and Dolan, 1998) have shown that when the general public is asked to allocate health resources, it not only has health gains —efficiency— in mind, but also the way in which these are distributed among the population — distributive equity. By doing so, society may be willing to give up a certain degree of efficiency —total number of QALYs— through obtaining a more equitable distribution. Therefore both concepts must be included in the social assessment of health care programs.

Theoretically, the concept of distributive equity has been incorporated into QALY literature through two lines of research. One has its beginnings in modern welfare economics (Wagstaff, 1991), and the other in multi-attribute utility theory (Bleichrodt, 1997). Both approaches propose variations in the aggregated QALY model which allow us incorporate the trade-off between

efficiency and distributive equity. Bleichrodt suggests to weaken the additivity condition underlying the model and formulates, under uncertainty, a multiplicative model defined on individual QALY gains. Starting with the parameters of the multiplicative function it is possible to analyse the extent to which society is willing to sacrifice efficiency in order to obtain more equitable distribution.

Wagstaff, while not giving up the additivity condition, proposes an isoelastic social welfare function inspired in the function established by Atkinson (1970). In this case, the distributive preferences are introduced by designating decreasing social values to each additional QALY received by the same individual. Dolan (1998) also analyses the properties of this function and its application in the allocation of health resources. Another way to introduce this decreasing social value in an additive function is through using a "social weight rate" as proposed by Olsen (1994). Both additive propositions will be analysed in greater detail in the third section. We will follow this approach because it allows us to use customary concepts in the inequality literature and it has been used previously in empirical studies. In this way our research can better be compared with previous empirical findings.

Parallel to the theoretical debate, some empirical studies have focused on

assessing the parameters of the social welfare function (SWF) that best fit with sampled social preferences—for example, Johannesson and Gerdtham (1996) estimate the shape of the SWF and Olsen (1994) estimates the social weight rate. However, these studies do not consider the possibility that the parameters can vary as a function of the number of QALYs gained or it is taken into account in a limited way—few and similar gains are considered. However, there might be a stronger preference for a more equitable distribution when individual gains are very great than when they are small. In this case, the parameters will not be constant. Furthermore, there could be preferences to concentrate gains when a small number of individual QALYs are obtained. There is some empirical evidence that show the existence of such preferences. For example, Pinto and Lopez (1998) show that people prefer concentrate when they compare small quality of life increments with life saving treatments. Also, Choudry et al. (1997) report that people prefer a program that increases life-expectancy in 20 years to 500 people that a program that increases life-expectancy in 1 year to 10 000 people. In other words, it is possible to prefer substantial improvements for a few individuals to "insignificant" improvements for many. Therefore, it is necessary to propose more flexible functional form of the SWF which, as opposed to those

which have been proposed before, allow us to describe a possible change in the pattern of preferences. This is the primary aim of this study.

In following section, we identify some conditions, frequently used in welfare economics under certainty, which are compatible with the AQM and with more flexible models. In section 3, we propose two measures which will allow us to calculate the inequality aversion degree. Based on these inequality aversion measures, the differences between the two additive SWFs, previously mentioned, are analysed. We finish the section by proposing a specific SWF that generalises the SWF underlying the AQM and lets us introduce different distributive preferences. Section 4 shows the results of an experiment we carried out whose aim is to construct a SWF that best fits the social preferences of the respondents and to analyse whether the degree of inequality aversion is independent of the provided gains or not. Section 5 discusses the results obtained. Finally, section 6 contains concluding remarks.

## 2 Derivation of the Social Welfare Function

The aggregated QALY model, and some extensions that try to introduce distributive considerations, can be derived from an additive SWF where social

welfare is defined over the individual health gains. In order to generate this utilitarian SWF, we must establish some conditions which will be presented after a short notational introduction —see Rodríguez and Pinto (1999) for a more extensive theoretical exposition.

The output of a given health care program is defined as a distribution of health gains, measured as the number of QALYs, the program provides to a given population. Let  $n \geq 3$  the population size and let  $T \in \mathfrak{R}_+^n$  the set of possible outputs that results from the implementation of different health care programs. An element of  $T$  is defined as a vector,  $\tau = (t_1, \dots, t_n)$ , where  $t_i \in \mathfrak{R}_+$  — $i = 1, \dots, n$ — indicates the number of QALYs individual  $i$  receives from the program. We assume without loss of generality that for each individual the possible gain of QALYs is non-negative. That is to say, we assume that there are no states worse than death.

The next step is to establish a criterion of social choice which allows us to order all the elements of  $T$  in an unambiguous rating. In order to do this, we consider that social preference relationship is complete and transitive —a weak order. Then, it can be represented by a value function —SWF— defined over  $\tau$ , that we denote by  $W(\tau)$ . Therefore, this function represent society's preferences. In addition the SWF is considered to depend positively

on individual QALYs —  $W(\cdot)$  increases in  $t_i$  (Pareto assumption).

It would seem appropriate to consider that the social preferences for two different distributions of health, which differ only in the health provision of a couple of random individuals, depend only on QALYs received by those two individuals (independence assumption).

These assumptions allow us to define an additive SWF in the following way  $W(\tau) = \sum_{i=1}^n u_i(t_i)$ , where  $u_i$  is a positive monotonic transformation defined over  $t_i$ , that reflects the interpersonal comparisons made by the society [see Debreu (1960) and Keeney and Raiffa (1976)].

Another frequently used assumption is that of anonymity (Bleichrodt, 1996). This assumption tells us that if a health distribution is a permutation of another distribution, then both distributions must have the same social value. Based on this assumption and a scaling assumption, we can define the SWF as,

$$W(\tau) = \sum_{i=1}^n u(t_i)$$

where  $u(t_i)$  indicates the social utility of  $t_i$  gain.

Function  $W(\tau)$  is compatible with different social preferences depending on the functional form it acquires  $u(t_i)$ . Suppose that  $u(t_i)$  is a continuous and twice differentiable function. Given that  $u'(t_i)$  defined as  $du(t_i)/dt_i$  is the

(social) marginal utility, it can be interpreted as the social weight designated to each additional unit of  $t$  received by individual  $i$  (e.g., Cowell, 1995). The reason for the latter affirmation is as follows. If a health care program produces a small change in the everyone's health,  $(\Delta t_1, \dots, \Delta t_n)$ , social welfare will rise,  $\Delta W = \sum_{i=1}^n u'(t_i) \Delta t_i$ . Therefore  $u'(t_i)$  act as a system of weights when summing the effects of the program over the whole population.

The SWF that underlies the AQM is reached immediately if we impose a restriction on the marginal utilities. Given that for this model an additional QALY always has the same social value,  $u'(t_i)$  must be constant independently of the value of  $t_i$ . Under this assumption,  $u^{(1)}(t_i) = t_i$  —or any positive linear transformation— and the SWF can be defined as  $W^{(1)}(\tau) = \sum_{i=1}^n t_i$ . In order to introduce the existence of a temporal discount rate we can simply suppose that  $t_i$  are QALYs that have already been discounted.

### 3 Distributive considerations

The number of QALYs provided by each health care program is indisputably a variable of interest, but not the only one. The distributive effects associated with each program are another variable that may be considered relevant by

society. In this case, each additional QALY received by the same individual can have different weights and, therefore,  $u'(t_i)$  can vary depending on the value of  $t_i$ . If we suppose that society prefers more equitable distributions — positive inequality aversion—, the weight of each additional QALY received by individual  $i$ , will decrease as the number of QALYs received increases. In this case,  $u''(t_i)$  defined as  $du'(t_i)/dt_i$  is negative — $u(t_i)$  is a concave function. If, on the other hand, there are preferences to concentrate gains —negative inequality aversion—, then  $u''(t_i)$  is positive or, equivalently,  $u(t_i)$  is a convex function.

The degree of aversion to inequality can be obtained through some measure that reflecting the marginal utility variation in the presence of variations in the quantity of (individual) QALYs. This measure allows to discover the extent to which society is willing to exchange efficiency for equity. There are two measures which are particularly appropriate, given the cardinality of  $u(t_i)$  —the expression  $u''(t_i)$  is not adequate because it variant to positive linear transformation of  $u(t_i)$ . One is a measure of absolute inequality aversion,  $\theta_a(t_i) = -u''(t_i)/u'(t_i)$ , and the other is a measure of relative inequality aversion —or the elasticity of marginal utility—,  $\theta_r(t_i) = -t_i [u''(t_i)/u'(t_i)]$ . These measures have there origins in Arrow (1965) and Pratts (1964) aver-

sion to risk measures. The latter tells us in what percentage the weight of each person,  $u'(t_i)$ , is reduced when the number of QALYs is increased by 1 percent.

Given that  $u'(t_i)$  is always positive, both measures are positive if society prefers to distribute health gains, they are negative if there are preferences for concentration, and they are equal to zero if society only has efficiency in mind (AQM). On the other hand, a constant  $\theta_a$  indicates that in the presence of equal changes in the patient health level —in this case number of QALYs—, the weight is modified in the same proportion, independently of the value of  $t_i$ . However, a constant  $\theta_r$  reveals that the weight is modified in the same proportion in the presence of equal proportional changes.

Inequality aversion measures allow us to analyse those normative postulates that underlie different SWFs. As mentioned in the introduction, in the literature on QALYs, under certainty, two ways are normally used for including distributive preferences starting from an additive SWF. Wagstaff proposes an isoelastic SWF that along with the anonymity assumption defines  $u(t_i)$  as

$$u^{(2)}(t_i) = \begin{cases} (1 - \varepsilon)^{-1} t_i^{(1-\varepsilon)} & \text{if } \varepsilon \neq 1 \\ \ln t_i & \text{if } \varepsilon = 1. \end{cases}$$

Olsen proposes using a social weight rate,  $1/(1+r)$ , when it comes to

assessing each additional QALY. In this case,  $u^{(3)}(t_i) = \sum_{j=1}^{t_i} [1/(1+r)]^j$ . We assume that discounted QALYs are used, otherwise the rate  $1/(1+r)$  reflects the social weight rate and the temporal discount rate in an indistinguishable way. Given that we have considered that  $t_i \in \mathfrak{R}_+$ , the continuous version of  $u^{(3)}$  is expressed as follows,

$$u^{(3)}(t_i) = \int_0^{t_i} e^{-rt} dt = \frac{1}{r} (1 - e^{-rt_i}).$$

It is obvious to see that positive (negative)  $\varepsilon$  and  $r$  values correspond to concave (convex) utility functions and, therefore, it would describe a positive (negative) inequality aversion. If  $\varepsilon$  and  $r$  are equal to zero it would indicate that maximising the number of QALYs is the only consideration of interest, therefore,  $u^{(2)} = u^{(3)} = u^{(1)}$ .

The main difference between the two functions is determined by their degree of inequality aversion. While the weights designated by  $u^{(2)}$  increase in the same proportion in the presence of identical proportional changes — decreasing  $\theta_a$  and constant  $\theta_r$  — the weights designated by  $u^{(3)}$  increase in the same proportion in the presence of equal changes in the level — constant  $\theta_a$  and increasing  $\theta_r$ . Therefore, the theoretical application of one or the other function requires normative postulates.

Besides normative postulates, it is interesting to know whether the SWF which best reflects social preferences coincides with any of the aforementioned functions or, otherwise, what properties characterise this new SWF. We ought to bear in mind that if there are different degrees of aversion to inequality in social decision-making depending on the value of  $t$ , then neither of the two previously mentioned functions would be valid. In this case it would be necessary to apply more flexible functions.

In this context, it would be suitable to define a social utility function, denoted as  $u^{(4)}(t_i)$ , that generalises the above mentioned formulations in the sense that these can be obtained as a particular case of  $u^{(4)}$ . A function that fulfils these requirements can be defined as,

$$u^{(4)}(t_i) = \alpha_1 e^{-\alpha_2 t_i} t_i^{\alpha_3}.$$

This function can have concave or convex sections depending on the value of the parameters. This is an important property because it allows us to represent social preferences with positive and negative inequality aversion in the same function and, therefore, it permits us to represent a change in the preferences pattern. In addition, if  $\{\alpha_1, \alpha_3\} = 1$  and  $\alpha_2 = 0$ , then,  $u^{(4)} = u^{(1)}$ ; if  $\alpha_1 = 1/\alpha_3$  and  $\alpha_2 = 0$ , then,  $u^{(4)} = u^{(2)}$ ; finally, if  $\alpha_1 = -1/\alpha_2$  and  $\alpha_3 = 0$ ,  $u^{(4)}$  will be a linear transformation of  $u^{(3)}$ .

## 4 Experiment

The aim of this experiment is to obtain a first approach to the function  $u(t_i)$  and, therefore, to the SWF. In order to do this, a set of health gains which we consider representative *ex ante* are assessed. Then the functional form that best fits these assessments is sought. Once  $u(t_i)$  is obtained, its properties are analysed, focusing on the influence that distributive effects have on the assessment of any health gain. Health gains were measured in years in full health in order to make the task easier for the people being surveyed.

The Person Trade-off (PTO) technique was used to designate social values to individual health gains. In short, this technique consists of presenting the person being surveyed with different allocations of numbers of patients and the health gains that they receive and then the surveyed person must say which allocations are considered equally preferred (Nord, 1992).

### 4.1 Design

The experiment was conducted with 61 undergraduate students —21 Economics students, 20 Political Science students and 20 Law students. The students were paid approximately \$16 for their participation. The experiment consisted of three meetings with the participants on three different days. At

the first meeting the aim of the study was explained to the participants. After that, they filled out a pilot questionnaire so they could become familiar with the kind of questions they would be asked at the second meeting.

The second meeting was carried out in different sessions with an average of five participants per session. Each one was shown different health care programs that were all directed at 20-year-old patients. By doing so we tried to isolate the effect that patient age can have on social decision-making, thereby avoiding each individual presupposing different ages. Each program consisted of a different pair  $(e, p)$ , where  $p$  is the number of patients who benefit from its application, and  $t$  is the health gain, measured in years in full health, that each one receives. For each program, the participant had to say how many 20-year-old patients,  $p^*$ , would have to receive a 10-years life increase in order to make him indifferent between both programs. In other words, once  $t$  and  $p$  have been fixed, they must give a  $p^*$  value such that the  $(t, p)$  and  $(10, p^*)$  allocations are equally preferred —PTO technique. Given the fact that in the pilot questionnaire we detected that the participants had some difficulties when trying to choose a concrete number of years, it was decided to use the “choice-bracketing” to calculate the  $p^*$  value. This mechanism consists of approaching the value through a series of successive

questions where it is always necessary to choose between two allocations — see appendix. Sometimes the designed choice-bracketing doesn't allow to get an exact value for  $p^*$  but an interval. In this case we take the intermediate value of that interval.

Our working hypothesis is that preferences for distributive effects can vary depending on the life-years increase that each patient receives. In order to test this, the participants assessed five different time increases: 1, 2, 5, 20 and 50 years. The number of patient,  $p$ , was selected in such a way that all of the programs provided the same total life-years increase and, therefore, they have the same value for the AQM. Accordingly, they assessed the following programs: (1, 100), (2, 50), (5, 20), (20, 5), (50, 2), where the first element refers to the (individual) life-years increase and the second element refers to the number of patients who received this increase.

In any experiment of this kind it is important to analyse the extent to which the use of another technique provides similar results —consistency across methods. For this, after applying the choice-bracketing to all allocations, we provided each participant with six cards that they had to rank from more to less preferred —direct ordering technique (DO). Each card corresponded to each of the previously assessed programs. The additional card

corresponded to that program in which life was increased by ten years for ten patients —(10,10). It did not make any sense to assess this allocation before because the ten-years increase was used to compare the rest. Finally, the participants were asked to briefly justify their ranking.

Two weeks latter, we organised a third meeting. The purpose was to check if the results are consistent in time —temporal reliability (retest). Therefore, they had to repeat the experiment.

## 4.2 Method of analysis

First, we excluded from our analysis those individuals that did not make trade-offs. If the participants do not make trade-offs the  $p^*$  values obtained do not have any meaning.

Next, from valuations of participants obtained with the PTO technique, we calculate the  $p^*$  average value for each one of five time-increases and number of patients allocations. We verify if each of the five average  $p^*$  are significantly different from the rest. Notice that if the AQM assumptions are correct then none of the allocations should have a significantly different value from 10.

Based on the individual  $p^*$ , we obtain the social value that each partici-

pant assigned to the five increases in question. Given that for each allocation  $(t, p)$  we have obtained one  $p^*$  value such that this allocation is equally preferred to the allocation  $(10, p^*)$ , its social value should be the same. If we assume that the social value of increases in life-years is independent of population size (Olsen, 1994) we get

$$u(t) * p = u(10) * p^*.$$

It should be noted that this assumption is what allows us to arbitrarily choose the 5 values of  $p$ . In addition, given that all of the time increases are assessed in relation to a 10-year-increase value, this can be established arbitrarily, therefore, we make  $u(10) = 10$  and the social value of each time increase,  $t$ , is expressed as  $u(t) = 10 * p^*/p$ . Lastly, we look for the functional form,  $\hat{u}(t)$ , that best fits with these values. The aim is to obtain assessments for all those gains which were not directly assessed. Given that we want to avoid imposing any restrictions a priori, different regressions are estimated using Ordinary Least Squares until finding that which display a better goodness of fit.

As mentioned, to verify the consistency across methods, we have used the DO in addition to the PTO. While it is true that the ordering technique does not allow us to obtain cardinal values, the resulting rankings should

coincide with those obtained with PTO, at the individual level as well as at the social level —the latter if the method of aggregation is the same. For this, we transform the cardinal (individual) responses, obtained with PTO, to ordinal responses —ranking. To test the correlation between the two orderings at the individual level, Spearman rank correlation coefficient (SCC) was calculated for each participant. Then, we calculated the average SCC of all participants.

In order to analyse the correlation at the social level, the individual rankings obtained by both techniques were aggregated using the Borda rule. In this way, two social orderings were obtained, denoted as S-PTO and S-DO. To assess the degree of coincidence between both orderings, we apply both Spearman and Kendall rank correlation coefficients. SCC and KCC are non-parametric techniques which are applicable to ordinal data. Their values lie between -1 and 1, a higher value indicating stronger positive association between the ranks. The KCC is not used to evaluate the correlation on an individual level because it is necessary that any card has the same position in the ranking. However, it has been observed that this does not occur at the individual level.

Finally, to check temporal reliability, we analyse the degree of individ-

ual coincidence between the initial answers and those obtained two weeks later for the same questions. To analyse the correlation between the ranking from initial DO and that one from the retest, we use SCC. To analyse the correlation between the valuations resulting from initial PTO technique and that one from the retest, we calculate Pearson linear correlation coefficient (PCC).

### 4.3 Results

First, we excluded from our analysis those individuals that did not make trade-offs. We had to exclude 16 out of the 61 participants (26%). Those people always chose the pairs with greater number of patients (10 participants) or the pairs with greater number of years (6 participants).

Table 1 shows the average assessment —right column— for each allocation of life-years increases and number of patients —displayed in the left— obtained using the PTO technique. It should be noted that the assessment indicates the average number of the patients who would have to receive a 10-healthy-life-year increase in order for the participants to become indifferent to the allocation to the left.

[insert table 1]

Once we have the average valuation, and before making some comments about results, we must carry out some contrasts to know if these valuations are significantly different from one another. In the right columns, under the  $p^*$  value, the t-Student statistic is shown which allows us to test whether the average value is statistically different from 10. As can be seen in the table, the average values are significant at a significance level of 95% except for the (20, 5) allocation which is at 90%. To compare the remaining average values a mean difference contrast was done. Although not shown here, the only pairs whose differences is not statistically significant are [(2, 50), (50, 2)] and [(5, 20), (20, 5)].

Starting from the average assessments it is possible to analyse the distributive preferences. We must bear in mind that given two allocations  $(t', p')$  and  $(t'', p'')$ , whose  $p^*$  values are  $p^{*'} and  $p^{*''}$ , respectively, the participants prefer to distribute (concentrate) gains if when  $p' > p''$  then  $p^{*'} > p^{*''}$  ( $p^{*'} < p^{*''}$ ). Table 1 show that they prefer to distribute gains when the individual gain is “sufficiently” great and concentrate them when the individual gain is small. For instance, they prefer to give 10 additional life-years a 10 patients, that 20 additional life-years a 5 patients (preferences for distribution). However, they prefer to give 5 years to 20 patients that 1 year to 100$

patients (preferences for concentrate).

Based on the individual  $p^*$ , we obtained the social value that each participant assigns to each time increase — $u(t)$ . Starting from these values, we have estimated different functions in order to look for the one which best reflects the participants preferences. Amongst tested functions that one that display a better goodness of fit is the  $u^{(4)}$  function, defined in the section 3. To estimate this function, we transform it into a linear equation applying logarithms. In this way, we obtain

$$\ln u(t) = \ln \alpha_1 - \alpha_2 t + \alpha_3 \ln t.$$

The estimated equation is the following,

$$\widehat{\ln u(t)} = - \underset{(-11.05)}{0.807} - \underset{(-5.67)}{0.026} t + \underset{(24.32)}{1.435} \ln t$$

$$R^2 = 0.86$$

As can be seen, all the parameters are significant. The function explains 86% of the total variability, which is a good result if we keep in mind the number of people interviewed and the uncommon character of the questions. This function combine a convex and concave shape. Its properties are displayed in the next section.

As far as the consistency across methods is concerned, table 2 shows the

S-PTO, the S-DO and —in the lower part— SCC and KCC between both rankings. In addition, the average SCC of all participants is showed. Both methods provide similar orderings —therefore, a high correlation coefficients—, suggesting a high consistency across methods both at the social level and at the individual level. Finally, we analysed the reliability of the results studying temporal consistency. We get an average SCC of 0.93 between initial DO and that one from the retest and an average PCC of 0.44 between initial and final values obtained with PTO. This suggest a high stability of preferences with regard to the ranking but a weaker stability with regard to the values.

[insert table 2]

## 5 Discussion

This experiment has allowed us to estimate the parameters of the social utility function for healthy life-years increases, whose values are showed in  $\widehat{\ln u(t)}$  equation. Writing this equation in his original form, we get

$$\hat{u}(t_i) = 0.446 e^{-0.026 t_i} t_i^{1.435}.$$

The functional form of  $\hat{u}(t_i)$  lets us analyse distributive preferences. Starting from a simple derivation exercise we find that  $u''(t_i)$  is positive for  $t$

values less than 9.09 and negative for the rest of the viable values. Figure 1 represents the function  $\hat{u}(t_i)$ . The function starts out being slightly convex, taking on a concave shape start with a certain value that corresponds to  $t = 9.09$ . This information has very important qualitative implications. When the gains are less than 9.09 years, the average participant prefers to concentrate those gains, but if the gains are greater he prefers to distribute them. In this way the assumption that the distributive preferences depend on health gains is supported in the sense that the participants prefer to distribute health gains as long as they provide a reasonable life-time increase and, on the other hand, they prefer to concentrate health gains rather than give insignificant gains to many people.

[insert figure 1]

Using this as a starting point, we will be able to obtain the associated SWF value for any health care program  $\tau = (t_1, \dots, t_n)$ , expressed as follows,

$$\hat{W}(\tau) = \sum_{i=1}^n \hat{u}(t_i) = 0.446 \sum_{i=1}^n e^{-0.026 t_i} t_i^{1.435}.$$

As Wagstaff and Dolan report, the indifference curves of the SWF provide another interesting way to analyse distributive preferences. Figure 2 shows the indifference curves of  $\hat{W}(\tau)$  supposing  $\tau = (t_1, t_2)$ . For individual values

less than 9.09 (area I) we find concave indifference curves and, therefore, gains are preferred to be concentrated: given a total amount of health gains, the allocations that concentrate gains are always placed on a higher indifference curve than those which distribute them. For larger increases (area II) we can point out convex indifference curves indicating preferences for more equitable distribution. We cannot say anything a priori about (symmetrical) areas III and IV. Given that both areas combines gains where there is a preference for distribution with gains where there is a preference for concentration, the final result will depend on the specific gain in question.

[insert figure 2]

Following the theoretical exposition, the measures of absolute and relative inequality aversion  $-\theta_a$  and  $\theta_r$ , respectively— were calculated. Obviously, both measures are negative for values less than 9.09, indicative of the existence of negative inequality aversion. From this value, both parameters are positive and, therefore, there is positive inequality aversion. It is interesting to analyse the trajectory both these indicators follow. It is easy to verify that  $d\theta_a(t_i)/dt_i$  and  $d\theta_r(t_i)/dt_i$  are positive for all  $t_i$  analysed. Given that both coefficients are increasing with respect to the health gain, the greater the number of years provided to each individual, the greater the inequality

aversion is, in both absolute and relative terms.

## 6 Conclusion

It has been suggested by a number of economists that the distributive preferences should be included in the social valuation of QALYs. In this paper, we have proposed a SWF that allows us to represent different social preferences, including the additive ones proposed in the literature on QALYs until now. Moreover, this function lets us to combine preferences for concentration and distribution, an issue suggested by some authors, which had not been formulated theoretically.

The experiment results have confirmed that participants have different distributive preferences depending on the individual life-years increase obtained. Therefore, the set of SWF proposed until now — $u^{(1)}, u^{(2)}$  and  $u^{(3)}$ — do not provide a suitable approximation of preferences for the group under study, given that these functions do not allow us to combine concave and convex sections of  $u(t_i)$ .

However, it is important to stress the pilot nature of this experiment and therefore its limitations. On the one hand, we have chosen a convenient

sample but it is necessary to select a more representative sample to obtain more robustness in results. On the other hand, the  $u(t_i)$  estimated starts to decrease for life-time increases bigger than 55 years. This is inconsistent with the monotonicity assumption —and with the common sense. However, this anomaly is not a limitation of the function proposed but of the experiment accomplished. It should be noted that the biggest increase of time evaluated is 40 years, then our results are only relevant for time increases no bigger than 40 years. Finally, to estimate  $u(t_i)$  the lexicographic participants have been excluded because they do not make trade-offs. Therefore, it should not be forgotten that the resulting function leaves the preferences of these participants unexplained.

However, in spite of these limitations, we have covered the initial purpose of this paper: to assess the importance of distributive effects in social valuation of health gains and to what extent this importance can vary depending on the size of the gain.

## Appendix

Part of the questionnaire we used can be found below. One of the 5 time increase and people allocations that the participants have assessed through the choice-bracketing is included as an example.

In this section we will always show 2 treatments: A and B. The treatments are different from each other in the increase of healthy life-years that are provided to the patient, and in the number of people who receive gains. We must bear in mind that all the patients are 20 years old. You must say whether you prefer treatment A, treatment B, or you are indifferent to both. Depending on your choice the questionnaire continues in the following way:

-If you choose an option where you find the word "stop", circle the word and go on to the next table (in which treatment A has been varied).

- If you choose an option where you find the word "continue", go on to the next line.

By way of simplification we will use the following notation:

Healthy life - year increases for the patient = "Years"

Number of people receiving gains = "People"

I prefer treatment A = "Pref. A"

I am indifferent to A and B = "Same"

I prefer treatment B = "Pref. B"

The treatments are the following:

<i>Treatment A</i>		<i>Treatment B</i>				
<i>Years</i>	<i>People</i>	<i>Years</i>	<i>People</i>	Pref. A	Same	Pref. B
5	20	10	1	continue	stop	stop
5	20	10	20	stop	stop	continue
5	20	10	3	continue	stop	stop
5	20	10	18	stop	stop	continue
5	20	10	5	continue	stop	stop
5	20	10	15	stop	stop	continue
5	20	10	8	continue	stop	stop
5	20	10	12	stop	stop	continue
5	20	10	10	stop	stop	stop

## References

- [1] Arrow, K., 1965, Aspects of the theory of risk-bearing (Yrjo Jahnsson Saatio, Helsinki).
- [2] Atkinson, A.B., 1970, On the measurement of inequality, *Journal of Economic Theory* 2, 244-263.
- [3] Bleichrodt, H., 1997, Health utility indices and equity considerations, *Journal of Health Economics* 16 (1), 65-91.
- [4] Choudry, N., P. Slaughter, K. Sykora and C. Naylor, 1997, Distributional dilemmas in health policy: large benefits for a few or smaller benefits for many, *Journal of Health Services Research and Policy* 2 (4), 212-216.
- [5] Cowell, F.A., 1995, *Measuring Inequality* (Prentice Hall/Harvester Wheatsheaf).
- [6] Debreu, G., 1960, Topological methods in cardinal utility theory, in: K. J. Arrow, S. Karlin and P. Suppes, eds. *Mathematical methods in the social sciences* (Stanford University Press) 16-26.
- [7] Dolan, P., 1998, The measurement of individual utility and social Welfare, *Journal of Health Economics* 17, 39-52.
- [8] Johannesson, M. and U-G. Gerdtham, 1996, A note on the estimation of the equity-efficiency trade-off for QALYs, *Journal of Health Economics* 15, 359-368.
- [9] Keeney, R.L. and H. Raiffa, 1976, *Decisions with multiple objectives*, (Wiley, New York).
- [10] Nord, E., 1992, Methods for quality adjustment of life years, *Social Science and Medicine* 34 (5), 559-569.
- [11] Nord, E., J. Richardson, A. Street, H. Kuhse and P. Singer, 1996, The significance of edad and duration of effect in social evaluation of health care, *Health Care Analysis* 4, 103-111.
- [12] Olsen, J.A., 1994, Persons vs years: two Ways of eliciting implicit Weights, *Health Economics* 3, 39-46.

- [13] Pinto J.L. and A. Lopez, 1998, More evidence on the plateau effect, *Medical Decision Making* 18, 287-294.
- [14] PlisKin, J.S., D.S. Shepard and M.C. Weintein, 1980, Utility functions for life years and health status, *Operations research* 28, 206-24.
- [15] Pratt, J., 1964, Risk aversión in the small and in the large, *Econometrica* 32, 122-136.
- [16] Rodríguez, E., J.L. Pinto, 1999, The Significance of the Age in Social Assessment of Health Care: Theory and Evidence, Documento de trabajo 9904, University of Vigo.
- [17] Torrance, G.W., 1976, Toward a utility theory foundation for health status index models, *Health Services Research*, winter, 349-369.
- [18] Wagstaff, A., 1991, QALYs and the the equity-efficiency trade-off, *Journal of Health Economics* 10, 21-41.

Table 1: Assessment of Treatments

<i>Time, Patients</i>	<i>Patients (p*) (statistic t)</i>
10,10	10
20,5	9.23 (-1.90)
5,20	8.93 (-2.17)
2,50	7.49 (-2.99)
50,2	7.40 (-5.39)
1,100	6.74 (-3.49)

Table 2: Ranking of treatments  
(from more to less preferred)

<i>Time, Patients</i>	
<i>S-PTO</i>	<i>S-DO</i>
10,10	10,10
20,5	5,20
5,20	20,5
50,2	50,2
2,50	2,50
1,100	1,100
KCC=0.86	SCC=0.94
Individual SCC (average)=0.81	

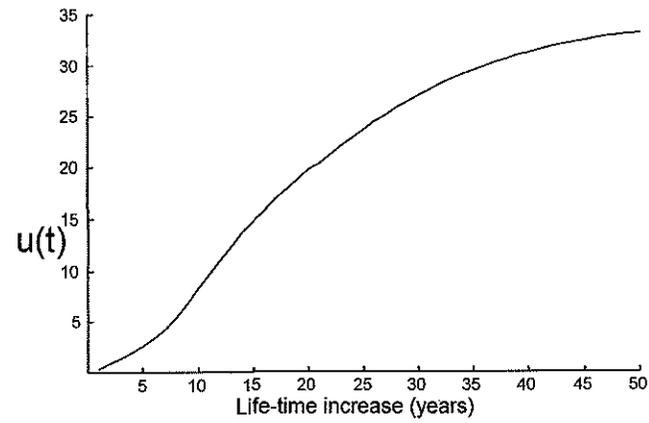


Figure 1: Social value of life-time increase

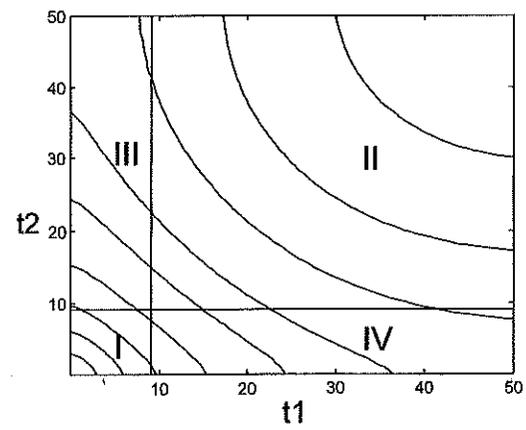


Figure 2: Indifference curves of the estimated SWF