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3 **A proposed taxonomy of health related social welfare functions**

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8
9 **Abstract:**

10 There is an emerging literature on the health related social welfare function, or in
11 other words, on aggregating QALYs. The baseline method for aggregating health
12 gains is simply to add them up across patients without using any weights
13 (equivalently, by using uniform weights). However, some have argued that not all
14 QALY gains should be equally valued in a publicly funded health care system. The
15 paper aims to present a taxonomy of approaches to aggregating health gains. The first
16 part of the taxonomy concerns the policy desiderata (eg., health, as judged by patients
17 / as evaluated by the public / what perspective / etc), and the second part about
18 different types of aggregation (eg. simple sum / weighted sums / inequality aversion /
19 inequity aversion etc). The taxonomy will be theory-driven. In other words, it does
20 not start from the body of existing studies and try to group them. Rather it starts from
21 a list of theoretical concerns and examines the implications of different subsets of
22 them. The taxonomy will shed light on the relationships between different
23 approaches to aggregating QALYs.

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25
26 **Key words**

27 QALYs, aggregation, health related social welfare function, equality, equity

28 **0. Introduction**

29

30 We will break the problem into two parts. The first is about what it is that should be
 31 maximised, or distributed. People have referred to this as the maximand or
 32 distribuendum. In this paper, we will use the term “desideratum”, to mean what it is
 33 that is treated as the good in question so that efficiency requires producing more of it
 34 and equity requires distributing it fairly. The second part is about how to aggregate.
 35 The assumption is that each individual has some level of the desideratum, and that
 36 social welfare is a function of these levels: the question is what kind of function
 37 should this be.

38

39

40 **1. The policy desiderata**

41

42 The key issues addressed in this section are: what the desideratum is, and what is the
 43 source of its value. Two kinds of desideratum are discussed: utility and health; and
 44 two kinds of source of value are distinguished: welfarism and non-welfarism.

45 Further questions to consider are whether the desideratum is cardinally measurable,
 46 and interpersonally comparable.

47

48

49 *1.1. Welfarism and utility*

50

51 Utilitarian economic theory is welfarist. Welfarism holds that the only information
 52 that is relevant to assessing social welfare is individual utility (see for example Sen,
 53 1979). In other words, the policy desideratum is individual utility. Neoclassical
 54 economics assumed that individual utility is not cardinally measurable, and is not
 55 interpersonally comparable. The compensating variation is a conceptual tool devised
 56 by Kaldor to convert non-cardinal non-comparable utility information into monetary
 57 value, which is cardinal and comparable (NB. although the *utility* you derive from
 58 your £20 cannot be compared with the utility I derive from my £20, your £20 and my
 59 £20 are not only comparable but worth the same at the market place). Subsequent
 60 approaches within microeconomics have relaxed the non-cardinality requirement, and
 61 for instance expected utility theory implies that one can talk about not just increases
 62 and decreases but also about the size of increases and decreases in utility, and thus
 63 corresponds to a re-introduction of cardinality.

64

65 In addition, neoclassical economics assumes consumer sovereignty. This means that
 66 the individual himself is the best judge of his own welfare, or in other words of how
 67 much utility any given economic activity will yield for him. Let us call the individual
 68 in this context as the “informed consumer”. The informed consumer is assumed to
 69 know what it feels like to have different health problems, is assumed to be rational,
 70 and selfish (as in the economic sense; ie. only taking into account one’s own utility).

71

72

73 *1.2. Welfarism and health*

74

75 In health economics, the QALY (Quality Adjusted Life Year) is a commonly used
 76 quantitative desideratum. The QALY is a composite measure of duration of survival
 77 and the health related quality of life (HRQOL). The QALY can be interpreted under a

78 fully welfarist set up, and there is a growing literature dedicated to the identification
 79 of the set of conditions that need to be met in order for the QALY to be interpreted as
 80 a representation of individual utility.

81
 82 The most basic, or “linear” QALY model asserts that

$$83 \quad U(Y, Q) = Y \cdot H(Q), \quad (1)$$

84
 85 where U is the individual utility function over life years (Y) and HRQOL (Q) and H is
 86 a utility function defined on health states. This linear QALY model is the standard
 87 QALY model - when people refer to “the” QALY model, they almost always mean
 88 model (1). From an EU perspective, the claim that individual utility can be
 89 represented by the product of life years and the utility over states of health depends on
 90 the validity of a series of assumptions. Pliskin, Shepard and Weinstein (1980) proved
 91 that (1) holds if duration and health quality are mutually utility independent, constant
 92 proportional time tradeoff holds, and Fishburn’s marginality property holds.
 93 Subsequent research showed that these assumptions could be substantially simplified
 94 (Bleichrodt, Wakker, Johannesson, 1997; Miyamoto, 1999).

95
 96
 97 Empirical research shows that people do not value the survival duration linearly
 98 (Miyamoto, Eraker, 1985, 1989), so one may question the empirical validity of the
 99 standard linear QALY model. However, it may be argued that it is a convenient and
 100 reasonable approximation (see Miyamoto, Eraker, 1985; Doctor et al, 2004).

101
 102 Of interest is how to assess the quality adjustment weights to represent HRQOL. The
 103 welfarist answer is to ask individuals as the recipient of health. This can be justified
 104 in two ways: because they know best, and because it’s their health. If the issue is
 105 knowledge, then in certain health conditions that affect mental capacities, it might be
 106 better to rely on carers’ or experts’ views than on patients’ views. Let us call the
 107 *compos mentis* patient the “*capable patient*”. The capable patient is assumed to know
 108 what it feels like to have the health problem in question and to be rational and selfish.
 109 Capable patients who suffer a specific health problem (call it “health state X ”) are
 110 interviewed with respect to their preferences for health states, including X . Other
 111 capable patients who are suffering from health state Y are interviewed with respect to
 112 Y . Utilities for states X and Y are placed on the same scale by having reference points,
 113 full health and dead, included among the health states that both groups evaluate, i.e.,
 114 the utility of dead and full health are assumed to be identical in the two groups, so that
 115 the ratios $(U(\text{full health}) - U(X)) / (U(\text{full health}) - U(\text{dead}))$ and $(U(\text{full health}) -$
 116 $U(Y)) / (U(\text{full health}) - U(\text{dead}))$ can be compared. If we set $U(\text{full health}) = 1$ and
 117 $U(\text{dead}) = 0$, then these ratios become especially easy to interpret (Fryback &
 118 Lawrence, 1997).

119
 120 An alternative is to ask non-patients to imagine themselves in various health states
 121 among which are included full health and death. Since non-patients do not know first
 122 hand what it is like to be in these hypothetical states, it is crucial that they be given
 123 enough information to carry out the evaluation task. Let us call such respondents
 124 “*informed non-patients*”. The informed non-patient is assumed to know about ill
 125 health states, but he himself is not ill; he is assumed to be rational and selfish.

126
 127

128 *1.3. Non-welfarism and health*

129

130 On the other hand the desideratum in health economics has also been perceived to be
 131 health per se, not because it is valued by individuals as patients or consumers
 132 (although it may well be) but because it is valued by the public at large or the relevant
 133 decision makers (eg. policy makers in the NHS or the Department of Health). This is
 134 referred to as “extra-welfarism” (Culyer, 1989), “non-welfarism” (Tsuchiya and
 135 Williams, 2001), or “the decision-makers’ approach” (Sugden and Williams, 1978).
 136 Here, under non-welfarism, health per se is regarded as the desideratum based on its
 137 societal value, independently of how recipient individuals appreciate it. This is in
 138 contrast to welfarism (1.2 above), where health was the desideratum precisely because
 139 and to the extent that individuals as patients or consumers appreciate it.

140

141 The number of years an individual lives is an objective matter, so the life year
 142 component of the QALY is not about judgement, and the crude number of years is
 143 used. The implication, in parallel to the welfarist case above, is that the societal value
 144 of health is linear in the number of years of survival.

145

146 Regarding the method of assessing HRQOL, non-welfarism argues that, since in a
 147 publicly funded health care system it is ultimately about how to use tax moneys, it
 148 should be based on what members of the tax paying citizenry think about different
 149 health outcomes across society; in other words, the judgement should come from a
 150 societal perspective. Let us call the individual in this context the “*informed citizen*”.
 151 The informed citizen is assumed to know what it feels like to have different health
 152 problems, is rational, and is self-less in the sense that she will not make judgements in
 153 order to forward her own case, or to advance the case of one particular health problem
 154 over another (see for example, Gold et al, 1996).

155

156 Note that the informed consumer, non-patient, and citizen are in effect the same
 157 person who assesses health states from different perspectives. The capable patient
 158 can also be the consumer or the informed citizen by adopting an appropriate
 159 perspective. Consequently, the same valuation methods (eg. standard gamble, time
 160 trade off, visual analogue scale) can be used to elicit values from any of these
 161 perspectives. The critical difference lies in the framing of the valuation task for the
 162 respondent - from what perspective should the respondent evaluate the health states?
 163 It should be noted that there are not many actual valuation studies that use the societal
 164 perspective. For example, the EQ5D valuation exercise asked in their TTO exercise
 165 whether the respondent themselves preferred to live in life A [longer life in less than
 166 full health] or life B [shorter life in full health] (Dolan, 1997), which is completely
 167 welfarist. Strictly speaking, non-welfarist TTO should ask whether health care
 168 resources should be allocated to bring about life A or life B. This should perhaps be
 169 contrasted against the claim that an economic evaluation that uses QALYs is carried
 170 out from the non-welfarism perspective. The only set of HRQOL weights that
 171 currently exist that are non-welfarist is likely to be the Disability Weights which used
 172 the person trade off method, and was developed for use in the calculation of the
 173 Global Burden of Disease (World Bank, 1993).

174

175

176 *1.4. Non-welfarism and utility?*

177

178 Current practice of non-welfarism means that what matters is the size of the health
179 change itself, independently of how this is actually appreciated by individual patients
180 themselves. As such, there is no scope to incorporate individual utility into non-
181 welfarism.

182

183 However, it should be noted that non-welfarism does not necessarily mean the
184 rejection of individual utility to affect social welfare, and there may be scope to
185 explore this currently vacant cell further.

186

187

188 **2. The aggregation rule**

189

190 The key issues addressed in this section are: what the aggregation rule is, and if there
191 are any weights involved what the justifications for the weights are and how they are
192 determined. Aggregation rules will not preclude any particular desideratum, but may
193 have higher affinity with either welfarism or non-welfarism.

194

195

196 *2.1. The least restrictive aggregation rule*

197

198 By far the least restrictive aggregation rule says nobody should lose or be made worse
199 off (viz. the Pareto criterion). It does not require cardinal measurability or
200 interpersonal comparability of the desideratum, which could be utility or health. It is
201 applicable under either welfarism or non-welfarism. However, it is not the most
202 useful aggregation rule, since it is highly incomplete (ie. there will be multiple
203 outcomes that cannot be rank ordered against each other).

204

205

206 *2.2. The simplest aggregation rule*

207

208 The simplest aggregation rule is to add up the changes in the desideratum across
209 individuals without any weights (equivalently, with uniform weights) so that the
210 outcome with the largest total is the best outcome. For this to make sense, the
211 measure of the desideratum needs to satisfy cardinality and comparability. This
212 aggregation rule is applicable to both welfarism and non-welfarism, and in effect this
213 is what cost benefit and cost effectiveness analyses do. Under non-welfarism, equal
214 weights can be justified with reference to what the relevant policy makers think or
215 what members of the public support from the societal perspective. A curious issue is
216 how to justify the use of uniform weights under welfarism.

217

218 Equal weighting can be inferred from a “permutation axiom” that was proposed by
219 Camacho (1979, 1980) in his repetitions approach to the foundations of cardinal
220 utility. In the repetitions approach, the individual is asked to state preferences for
221 arbitrarily many repetitions of a given riskless choice, e.g., the choice of wine at a
222 given restaurant. As Wakker pointed out (personal communication to JM), the
223 choices could be interpreted as the outcomes for different individuals in a society
224 rather than as outcomes of repeated choices. Here we will show that equal weighting
225 follows from the permutation axiom under a social welfare interpretation. The

226 permutation axiom states that we should be indifferent between social distributions
 227 that simply permute the identities of the persons who experience the various
 228 outcomes. For example, suppose that society contains only three individuals, A , B ,
 229 and C , who are equal in all relevant aspects. The following table shows different
 230 ways that health outcomes x , y , and z could be distributed among these three
 231 individuals.
 232

Societal Distribution	Outcome for A	Outcome for B	Outcome for C
Distribution #1	x	y	z
Distribution #2	x	z	y
Distribution #3	y	x	z
Distribution #4	y	z	x
Distribution #5	z	x	y
Distribution #6	z	y	x

233
 234 We should be indifferent between these six social distributions because only the
 235 identity of people who experience the outcomes changes, not the number of people
 236 who experience the different outcomes. Concretely, the societal perspective should
 237 be indifferent between an outcome where you are very sick and I am healthy, and an
 238 outcome where I am very sick and you are healthy.
 239

240 Although this is presented as an indifference between distributions of outcomes, it can
 241 also be interpreted as indifference between utility changes. For example, suppose that
 242 U_A is the utility of the initial state of person A , U_B is the utility of the initial state of
 243 person B , and U_C is the utility of the initial state of person C , and let w_A , w_B and w_C
 244 be the respective weights assigned to the utility changes of these individuals. To see that
 245 the permutation axiom implies that $w_A = w_B = w_C$, note first that it implies
 246 $U(\text{Distribution } \#i) = U(\text{Distribution } \#j)$ for any i, j . Let us consider the case where $i =$
 247 1 and $j = 5$ (chosen arbitrarily). Then,
 248

$$\begin{aligned}
 249 \quad & w_A[U(x) - U_A] + w_B[U(y) - U_B] + w_C[U(z) - U_C] \\
 250 \quad & = U(\text{Distribution } \#1) - U(\text{initial state}) & (2) \\
 251 \quad & = U(\text{Distribution } \#2) - U(\text{initial state}) & (3) \\
 252 \quad & = w_A[U(z) - U_A] + w_B[U(x) - U_B] + w_C[U(y) - U_C] & (4)
 \end{aligned}$$

253
 254 where (3) follows from (2) because $U(\text{Distribution } \#i) = U(\text{Distribution } \#j)$ for any $i,$
 255 j . But (2) and (4) imply that
 256

$$257 \quad U(x)[w_A - w_B] + U(y)[w_B - w_C] + U(z)[w_C - w_A] = 0. \quad (5)$$

258
 259 Since (5) holds for any values of $U(x)$, $U(y)$, and $U(z)$, it must be that $w_A = w_B = w_C$.
 260

261 It should be noted that one could object that the permutation axiom is not an obvious
 262 norm. What we have sketched here is the argument that it implies equal weighting
 263 but have not provided an argument for its normative status. Furthermore we have
 264 implicitly assumed that the value of a policy that yields Distribution $\#k$ is equal to
 265 $U(\text{Distribution } \#k) - U(\text{initial state})$. A non-welfarist might well object to this.
 266 Indeed, Ubel et al. (2000) have dubbed this assumption, the ‘‘QALY trap’’, and have
 267 proposed an approach that avoids it (see, also, Nord et al., 1999). We present these
 268 arguments here not as a defence of the permutation axiom and the derivation from (2)

269 to (5), but to display the link between equal weighting in aggregation and more basic
 270 preference assumptions.

271

272

273 *2.3. The introduction of inequality aversion, or distributional weights*

274

275 If there is aversion to unequal distributions of the desideratum, then the aggregation
 276 rule can incorporate inequality aversion so that the marginal societal value of
 277 increased desideratum is greatest when it goes to the worse off individuals. This
 278 aggregation rule is blind to the characteristics of the individuals, and simply has the
 279 effect of equalising the distribution of outcomes. The degree of inequality aversion
 280 can be derived from the informed citizen, researchers, or policy makers, by using
 281 valuation methods that present two or more groups of patients and contrast outcomes
 282 that have larger total health (in terms of unweighted QALYs) but with less equal
 283 distribution of this and those that have smaller total health but with more equal
 284 distribution of this. For example, suppose there are two groups of equal size: M and
 285 F . In outcome 1, those in M can expect to live 70 QALYs and those in F can expect
 286 to live 80 QALYs. In outcome 2, those in M can expect to live 73 QALYs and those
 287 in F can expect to live 74 QALYs. Outcome 1 is more efficient and less equal, and
 288 outcome 2 is less efficient and more equal. The aim would be to ascertain the amount
 289 of efficiency people are willing to forego to obtain a more nearly equal distribution of
 290 the desideratum.

291

292 This type of unequal weighting is compatible with the permutation axiom, because
 293 these weights are attached to different distributions of initial health or health gain, and
 294 are not attached to particular individuals. However, the comparison between
 295 outcomes 1 and 2 requires a perspective that is concerned with distributions across
 296 society, as opposed to outcomes for individuals. Since the informed consumer and
 297 the capable patient are selfish, they are less suited as a source of determining the level
 298 of inequality aversion to use in aggregation. As such, this aggregation rule has higher
 299 affinity with non-welfarism (which is based on the societal perspective) than
 300 welfarism (which is based on the individual consumer perspective), not because
 301 welfarism is incompatible with unequal weights, but because welfarism cannot
 302 determine the level of inequality aversion. It has been noted that a similar effect can
 303 be achieved within welfarism by assuming diminishing marginal utility of income at
 304 the individual level, alongside an inequality neutral aggregation rule. This is because
 305 social welfare will be improved more by allocating additional income to the poor, or
 306 those with higher marginal utility of income. Nevertheless, while the effects are
 307 similar, the underlying reasons are completely different. With this latter case,
 308 equality is achieved as a side product of efficiency.

309

310 There has been further attempts to incorporate inequality aversion in welfarism, for
 311 instance by defining distributional weights so that the marginal social value of
 312 individual utility is decreasing in own income. The difficulty is, as long as one stays
 313 within a welfarist framework, it is not obvious who determines this weight, and how.

314

315

316 *2.4. The introduction of inequity aversion, or equity weights*

317

318 Within non-welfarism, if there is some notion of equity or justice that the informed
319 citizen, or policy makers support, then the aggregation rule can include equity
320 weights. For example, if a severe health problem is regarded as deserving of higher
321 priority (*ceteris paribus*), then this can be incorporated. Other candidate
322 considerations may include expected health outcome with treatment, age, cause of the
323 ill health, etc.

324

325 Elicitation of equity weights is an area where it is important to probe the reasons why
326 people support differential treatment of citizens with certain characteristics but not
327 others. Contrast this with typical utility assessments by standard gambles or time
328 trade off methods - rarely are respondents asked why they give the responses that they
329 give. When eliciting equity weights, researchers need to distinguish between
330 justifiable societal preferences and unacceptable views based on prejudices (eg.
331 differential treatment by irrelevant characteristics such as race, sexual orientation, or
332 religion). This has lead to the use of qualitative methods, typically in discussion
333 group settings, where participants are invited to exchange views and explain why
334 people with one characteristic should be given higher or lower priority than others.

335

336 Since qualitative studies do not imply specific values for quantitative weights, they
337 must be followed by quantitative elicitation exercises. These have often used person
338 trade off methods or benefit trade off methods. However, adaptations of more
339 conventional methods (eg. standard gamble or time trade off tasks for groups as
340 opposed to individuals) or more complex approaches based on random utility theory
341 (eg. discrete choice experiment, rank ordering, best-worst scaling) are also possible.
342 The key in all such cases would be to adopt a societal perspective. Respondents
343 would be asked to behave as informed citizens by introducing the “thin” veil of
344 ignorance, or by asking them to imagine themselves as committee members with the
345 task of making the best decision for society.

346

347 Again, since welfarism is embedded in the selfish consumer’s utility, it is difficult to
348 incorporate equity weights under this approach.

349

350

351 *2.5. The introduction of efficiency weights*

352

353 Treating some people rather than others can have efficiency knock-on effects. For
354 instance, in a serious crisis it makes more sense to save the life of a self-supporting
355 adult than that of an elderly person or a young child who will need support from
356 others to survive further. Under welfarism, this can be reflected in differences in the
357 compensating variation.

358 **References**

- 359
- 360 Bleichrodt H, Wakker P, Johannesson M (1997). Characterizing QALYs by risk
361 neutrality. *Journal of Risk and Uncertainty*, 15: 107-114.
362
- 363 Camacho A (1979). On cardinal utility. *Theory and Decision* 10, 131–145.
364
- 365 Camacho A (1980). Approaches to cardinal utility. *Theory and Decision* 12, 359–
366 379.
367
- 368 Culyer AJ (1989), The normative economics of health care finance and provision,
369 *Oxford Review of Economic Policy*, 5(1): 34-58.
370
- 371 Dolan P (1997). Modeling valuations for EuroQol health states. *Medical Care*,
372 35(11): 1095-1108.
373
- 374 Fryback D. G., & Lawrence, W. F. (1997). Dollars may not buy as many QALYs as we
375 think: A problem with defining quality of life adjustments. *Medical Decision Making*, 17,
376 276-284.
377
- 378 Gold MR, Siegel JE, Russell LB, Weinstein MC, Eds. (1996), *Cost-effectiveness in*
379 *health and medicine*. Oxford, UK: Oxford University Press.
380
- 381 Miyamoto JM (1999). Quality-adjusted life years (QALY) utility models under
382 expected utility and rank-dependent utility assumptions. *Journal of Mathematical*
383 *Psychology*, 43, 201-237.
384
- 385 Miyamoto JM, Eraker SA (1985). Parameter estimates for a QALY utility model.
386 *Medical Decision Making*, 5, 191-213.
387
- 388 Miyamoto JM, Eraker SA (1989). Parametric models of the utility of survival
389 duration: Tests of axioms in a generic utility framework. *Organizational Behavior*
390 *and Human Decision Processes*, 44, 166-202.
391
- 392 Pliskin JS, Shepard DS, Weinstein MC (1980). Utility functions for life years and
393 health status. *Operations Research*, 28, 206-224.
394
- 395 Sen A (1979), Personal utilities and public judgements: or what's wrong with welfare
396 economics, *The Economic Journal*, 89:537-558
397
- 398 Sugden R, Williams A (1978). *The Principles of Practical Cost-Benefit Analysis*:
399 Oxford University Press
400
- 401 Tsuchiya A, Williams A (2001), Welfare economics and economic evaluation. in
402 Drummond M, McGuire A, eds, *Theory and Practice of Economic Evaluation in*
403 *Health Care*, Oxford University Press
404
- 405 Wakker PP (1986). The repetitions approach to characterize cardinal utility. *Theory*
406 *and Decision* 20, 33–40.
407

408 World Bank (1993). *World Development Report 1993: Investing in Health*. Oxford
409 University Press.
410