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WTP- and QALY-Based Approaches to Valuing Health for Policy: Common Ground and Disputed Territory

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Abstract. This paper discusses links between two approaches to the value of health: the willingness to pay approach of environmental economics and the quality-adjusted life year approach of health economics. The approaches are used in cost-benefit and cost-effectiveness analyses of health interventions. Despite fundamental differences in the decision contexts and conceptual foundations of the two approaches, in current practice they are likely to lead to similar policy decisions. The paper also shows how research on the quality-adjusted life year (QALY) can be used to fill in gaps in the willingness to pay literature. The paper sketches a simple model that shows how to "QALY-fy the value of a statistical life;" i.e., how to combine QALY estimates with estimates of the value of a statistical life to estimate willingness to pay for morbidity risks.

Key words: cost-benefit analysis, cost-effectiveness analysis, willingness to pay, QALY

JEL classifications: I18, I31, J17

1. Introduction

Given the different decision contexts and intellectual histories of environmental economics and health economics, it is probably not surprising that they have tended to take different approaches to the value of human health. A common approach in environmental economics is to estimate societal willingness to pay (WTP) for changes in the risks to human health. The WTP estimates of the value of health risks are intended for use in cost-benefit analysis (CBA) of environmental regulations. A common approach in health

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economics is to estimate the change in quality-adjusted life years (QALYs). The QALY improvements are intended for use in cost-effectiveness analysis (CEA) of clinical decisions and public health interventions.[1]

In this paper I discuss links between the WTP-based approach of environmental economics and the QALY-based approach of health economics. In Sections 2 and 3, my goal is to provide a brief overview and synthesis of important issues in linking the two approaches, recognizing that many researchers may be unfamiliar with one or the other of the approaches.[2] A central question is whether the WTP approach and the QALY approach lead to similar public policy decisions. This question is not only of academic interest, but has direct relevance for current policy making. Since 1982, when President Reagan signed Executive Order 12291, federal agencies have conducted WTP-based CBAs of environmental and other regulations. Currently, the Office of the Management and Budget's guidance to Federal agencies on regulatory analysis continues to call for WTP-based CBAs, but also calls for "a CEA for all major rulemakings for which the primary benefits are improved public health and safety to the extent that a valid effectiveness measure can be developed...." (OMB 2003, p. 9).[3] The brief review of Section 2 suggests that the two approaches have much in common, so that in current practice they are likely to lead to similar policy decisions. However, the review in Section 3 of the decision contexts and conceptual foundations of the two approaches reveals some fundamental differences. These differences may mean that linking the WTP approach and the QALY approach may be more difficult than it appears at first look.

My second goal, for Sections 4 and 5 of this paper, is to make an original contribution showing how research on QALYs can be used to fill in gaps in the WTP literature. There is an extensive empirical literature on WTP for reductions in mortality risks – the so-called value of a statistical life. However, strictly speaking most of the estimates relate to the value a working-age individual places on reducing the risk of a sudden accidental death. There is much less evidence on how WTP for mortality risks varies with age or by cause of death (Kenkel 2003). The evidence on WTP for morbidity risks is similarly less well-established (Dickie and Gerking 2002). Because the research on QALYs addresses a wide range of health conditions, it is an attractive source of information to supplement and extend existing WTP estimates. Section 4 sketches a simple theoretical model that shows how to "QALY-fy the VSL": i.e., how to combine QALY estimates with estimates of the value of a statistical life to estimate the value of morbidity risks. However, Section 5 points out that because QALYs were not intended for such use, some aspects of their measurement are inconsistent with the WTP approach to valuing health. Section 6 is a brief conclusion.

2. Common Ground

Both WTP-based CBA and QALY-based CEA are methods for the economic evaluation of health interventions. As such, they share the same basic tasks "to identify, measure, value and compare the costs and consequences of the alternatives being considered." (Drummond et al. 1997b, pp. 8–9) The primary difference between the methods is the metric used to value health consequences – a monetary WTP versus a QALY. Because in CBA both costs and consequences are valued in monetary units, it leads to a simple decision rule: adopt all interventions for which the monetary value of the health consequences are greater than the costs. Because CEA yields estimates of the cost per QALY saved, the decision rule is somewhat different: adopt all interventions with cost per QALY saved below some cutoff value.[4]

Practitioners of CBA have placed a dollar on a QALY to express the results of any CEA in the same metric as used in CBA. Tolley et al. (1994, Table 16.1) combine an estimate that each QALY saved is worth \$120,000 with previously estimated cost-effectiveness ratios to calculate the net monetary benefits of a series of medical interventions. The U.S. Food and Drug Administration (FDA) uses a similar approach in evaluations of proposed regulations of tobacco and food products (U.S. FDA 1996, 1999a, 1999b). For example, the FDA (1999b) values each life year saved by a nutrition labeling regulation at \$100,000. Similar values for a life year are suggested by Zarkin et al. (1993) and Cutler and Richardson (1997). Miller et al. (2002) provide additional discussion of "monetizing QALYs" for WTP-based CBA.

Some practitioners of CEA have also advocated the use of a monetary value of a QALY, as the cutoff value in the CEA decision rule. One approach bases the cutoff value for an acceptable cost-effectiveness ratio by making comparisons to previous analyses. In an early example, Kaplan and Bush (1982) suggest that interventions with a cost-effectiveness ratio of \$20,000 per life year should be judged "cost effective by current standards," while interventions with cost-effectiveness ratios greater than \$100,00 per life year are "questionable in comparison with other health care expenditures." Adjusted for inflation, this implies a cutoff value per QALY of about \$200,000.[5] Another common comparison is the "dialysis standard" – the annual cost of caring for a dialysis patient – which implies a cutoff value per QALY around \$74,000–\$95,000 (Hirth et al. 2000). Using the same conceptual basis as some practitioners of CBA (Cutler and Richardson 1997; Tolley et al. 1994; Zarkin et al. 1993), some health economists also advocate valuing a QALY based on WTP. Johannesson and Meltzer (1998) suggest an estimate of the willingness to pay per QALY between \$190,000 and \$450,000. In the meta-analysis by Hirth et al. (2000), the median estimate of the WTP for a QALY was about \$265,000.

So practitioners of CBA and CEA seem to have converged on the value of a QALY in the range from $74,000 to $450,000. Practitioners of CBA tend towards higher values while practitioners of CEA tend towards the low end (and outside the U.S. sometimes even lower, see footnote 5). If a similar monetary value per QALY is used, CBA and CEA yield similar decisions about the desirability of health interventions. Phelps and Mushlin (1991) provide a more detailed discussion of what they call the "near equivalence" of CBA and CEA. They argue that while CBA explicitly places a dollar value on a QALY, CEA does so implicitly, and call for researchers to "set aside the artificial dispute" between the two approaches.

3. Disputed Territory

3.1. DECISION CONTEXTS

Although WTP-based CBA and QALY-based CEA are converging to some extent in current practice, the two approaches to valuing health have their origins in different decision contexts and different intellectual traditions. In terms of decision contexts, WTP-based CBA and QALY-based CEA have been typically used for somewhat different types of public and private sector decisions. WTP-based CBA was developed for what are clearly public sector decisions about policies to address market failures such as externalities. The social costs of these policies often have little or no impact on the budgets of the public sector agency involved. For example, most of the costs of stricter air quality regulations are imposed on the private sector, not the Environmental Protection Agency [EPA]. In contrast, CEA is typically used in decision contexts that involve explicit, pre-determined public sector budgets. For example, in 1989 Oregon's legislature decided to expand the number of persons covered under its Medicaid program, but to stay within a predetermined budget it put new limits on the number of services Medicaid would cover. The original plan created a list of condition-treatment pairs (e.g. appendicitis/appendectomy). For each pair a cost-effectiveness ratio was derived, and a prioritized list of services was created. (Blumstein 1997).[6] Similarly, a famous cost-effectiveness analysis of heart transplantations played a role in a decision to continue funding of heart transplants in the U.K. National Health Service (Drummond et al. 1997a). In such situations, CEA is advocated as a tool to help decision-makers choose a set of interventions that "maximize the aggregate health effect achievable by the resources used...." (Garber et al. 1996).

Not only are CBA and CEA used for different types of public sector decisions, but the methods also differ in that QALY-based CEA is increasingly used in the private sector. For example, while in the past pharmaceutical marketing involved a "detail man" pitching a new drug to a physician, the promotion effort now often includes providing information on cost-effectiveness to private payers and hospital formulary committees (Sloan and Grabowski 1997). A survey of representatives of managed care organizations in the U.S. found that in decisions about additions to drug formularies, nearly all used assessments of a new drug's clinical effectiveness, safety, and cost-effectiveness (Lyles et al. 1997). In these uses in the private sector, CEA is a tool that "assists patients and their agents in making decisions about health care...." (Garber 2000, p. 186) There has been a backlash against too much emphasis on cost containment, but as good agents for their patients third parties should base decisions on both the cost and the health consequences of medical care. Although in principle either CBA or CEA could be used for these decisions (Pauly 1995), in practice CEA has dominated the field of pharmaco-economics and outcomes research in the private sector.

Another difference in the decision contexts of CBA and CEA is the level of risk involved. The WTP approach in CBA typically concerns environmental, consumer product, and job safety regulations that address baseline risks on the order of magnitude of 1 in 10,000 or even 1 in 100,000 or 1 in 1,000,000 (Viscusi 1992, Table 14.5). In contrast, the QALY approach in CEA is often used in the context of clinical decisions that involve risks that are orders of magnitude higher. A typical example in CEA concerns treatment choices for a patient with a heart attack (Weinstein 1995). Data suggested that a 60-year-old patient with a heart attack faced a hospital mortality rate of almost 8%, but this could be reduced to 5.5% with an inexpensive treatment (streptokinase) or to 4.4% with a much more expensive treatment (recombinant tissue plasminogen activator). So where an environmental policy decision might involve sacrificing societal resources to save 1 of every 100,000 people in an exposed population, a clinical decision might involve spending more to save 1 more life out of every 100 heart attack patients. Non-linearities in risk-dollar tradeoffs mean that existing empirical estimates of WTP for risk reductions relevant for environmental policy making can not be extrapolated to provide estimates of WTP for the risk changes involved in many clinical decisions. However, in principle the WTP approach could be extended to develop the value of the larger risk changes common in clinical decision contexts. Indeed, Smith's (2003) review of contingent valuation studies in health care notes that a number of studies consider risk and uncertainty, although apparently only a few health care studies to date estimate WTP for changes in risks.

As a last comment on decision contexts, it should be noted that some recent applications of QALY-based CEA are in contexts that are similar to or identical to the typical WTP-based CBA. For example, Tengs and Graham (1996) examine the cost-effectiveness of 185 life-saving interventions to analyze the inefficiency that results from what they term "haphazard" public investments in life-saving activities. The interventions considered include regulatory efforts of the EPA and the FDA that have also been the subject of CBAs. In response to the OMB's interest in CEA, Hubbell (2002) performs a QALY-based CEA of air pollution regulations.

3.2. INTELLECTUAL TRADITIONS AND THEORETICAL FOUNDATIONS

Turning from decision contexts to intellectual traditions, the extent to which WTP-based CBA and QALY-based CEA share a common intellectual tradition is somewhat controversial. WTP-based CBA is an applied method from neoclassical welfare economics; CBA is a tool to determine whether a given policy change represents a potential Pareto improvement. Some health economists also ground CEA in welfare economics:

> "By describing CEA as a tool for improving general welfare, we place it squarely within the context of welfare economics. Welfare economics is concerned with the means by which we can assess the desirability – from the societal point of view – of alternative allocations of resources." (Garber et al. 1996).

As Garber et al. (1996) acknowledge, however, the principles of welfare economics suggest the use of CBA, not CEA. They defend the use of CEA on pragmatic grounds: "Our interest in cost-effectiveness analysis derives largely from its broad acceptance within the health care field, in contrast to the skepticism that often greets cost-benefit analysis in that arena." Standard texts on cost-benefit analysis are more disdainful of CEA. Sugden and Williams (1986) describe CEA as "a ***halfway house*** on the road to cost-benefit analysis," while Mishan (1988) observes that: "To be rather rude about it, the analysis of cost-effectiveness can be described as a ***truncated form*** of cost-benefit analysis...." (emphasis added). Even more recently, Brent (2003, p. xviii) describes QALY-based CEAs as "at best, ***short-cut*** CBAs or, at worst, ***incomplete*** CBAs." (emphasis added).

An important strand of recent research explores in detail whether CEA can be better grounded in neoclassical welfare economics. One strand of research uses neoclassical economic theory to provide guidance and to resolve disputes such as the correct treatment of future health care costs in CEA (e.g. Garber and Phelps 1997; Meltzer 1997; Meltzer and Johannesson 1999). Another strand of health economics research explores the conditions needed for the QALY model to represent individual preferences over a lifetime health profile. Possible conditions include: constant proportional trade-off, where an individual is willing to sacrifice a constant proportion of remaining life years for a given health improvement irrespective of the number of life years remaining; and risk neutrality over life years, where an individual is risk neutral with respect to gambles over life years for all health states (Dolan 2000). Bleichrodt and Quiggin (1999) and Klose (2003) extend this line of research to derive the conditions needed for the QALY model to represent individual preferences when lifetime utility depends not only on health but also on consumption.

Recent health economics research also explores in more depth the issues of when CEA can be viewed as an approach that is equivalent or nearly equivalent to CBA. Ironically, different researchers seem to attach different meanings to the term "equivalent," and so reach different conclusions about whether WTP per QALY has to be constant and the same for everyone. Bleichrodt and Quiggin (1999, p. 682) argue that because CBA imposes no restrictions on the form of lifetime utility, "to derive the conditions under which cost-effectiveness analysis is consistent with life-cycle preferences over consumption and health simultaneously answers the question under which conditions cost-effectiveness analysis is equivalent to cost-benefit analysis." In the models of Bleichrodt and Quiggin (1999), Hammitt (2002b) and Klose (2003), WTP per QALY is not constant but depends on factors such as remaining life expectancy and the magnitude of the QALY gain.

In contrast, Johannesson (1995) suggests that CEA can be interpreted as a CBA where WTP per QALY is assumed to be constant and the same for everyone. The argument is similar to the point made by Phelps and Mushlin (1991): when CEA uses a cutoff value of cost-per-QALY, the cutoff value is implicitly the monetary value of a QALY. Dolan and Edlin (2002) explore what assumptions about individual preferences are needed to yield a constant WTP per QALY. They show that as long as the axioms of expected utility hold and the QALY model is valid in a welfare economic sense, WTP per QALY will only be constant if illness does not affect the ability to enjoy consumption, a restrictive and counter-intuitive assumption. Dolan and Edlin (2002, p. 838) conclude that "there is currently no meaningful link between CBA and CEA" and go on to say that:

> "It appears to us that CBA and CEA have such fundamentally different ethical underpinnings, that it would seem futile to further attempt to reconcile them within the welfare economic paradigm."

Although the debate on the link between CBA and CEA continues (Hansen et al. 2004; Edlin 2004), Dolan and Edlin's concluding comment is similar to the views of other proponents of CEA who emphasize the difference in intellectual traditions. For example, Russell (1999) argues that: "Although it draws on much of the same theory, CEA is not cost-benefit analysis (CBA) in disguise ...." Weinstein (1999) cautions against "turning CEA into a mongrelized form of CBA" and argues that "CEA, unlike CBA, is not dictated by pure theory." Weinstein points out that welfare economic theory was only one of many criteria used to develop the recommendations of the Panel on Cost-Effectiveness in Health and Medicine.

Instead of welfare economics, CEA can be grounded in decision science and operations research. A textbook that takes this approach, written by a public health researcher rather than an economist, emphasizes the parallels between CEA and other decision analysis methods (Petitti 1994, p. 31):

> "Cost-effectiveness analysis compares the outcome of decision options in terms of their monetary cost per unit of effectiveness....The first four steps in a cost-effectiveness analysis are the same as in a decision analysis. The problem is identified and bounded, a decision tree is constructed, information to fill in the decision tree is gathered, and the decision tree is analyzed to determine the outcome of the decision options."

In addition to neoclassical welfare economics and decision science, CEA has also been grounded in extra-welfarism. Extra-welfarists "argue that health, not utility, is the most relevant outcome for conducting normative analysis in the health sector." (Hurley 2000).

Arguments grounding CEA in decision science or in extra-welfarism can be combined with the decision-maker approach to CBA. Unlike what has been called the Paretian approach, where the goal of CBA is to identify policies that are potential Pareto improvements, under the decision-maker approach the role of the analysis is to help achieve the objectives of the decision-maker, which may or may not correspond to the Paretian criterion (Sugden and Williams 1986, pp. 91–92). In this way, CEA as a decision science tool can be seen as providing admittedly incomplete guidance, requiring the decision-maker's preferences to complete the analysis. Applied to the public provision of health care, "Extra-welfarist have argued that, in fact, decision makers have declared that producing health is the primary objective of the health care system," (Hurley 2000). This provides a philosophical rationale for the use of CEA to maximize the health effects obtainable from a given health care budget.

3.3. SUMMARY

To sum up, WTP-based CBAs of health and safety typically address policies that impose costs that are often spread broadly over the private sector, and result in small reductions in health risks. The approach is firmly grounded in neoclassical welfare economics and takes a broad societal perspective on whether resources are being allocated to their most highly valued use. While CEA is sometimes used for very similar purposes, it was mainly developed for different decision contexts. Some practitioners of CEA also ground it in decision science or extra-welfarism, not neoclassical welfare economics. To the clinician, managed care organization, state Medicaid plan, or national health service, CEA provides practical help for decisions about the adoption of new medical procedures, insurance coverage for new pharmaceutical products, and so on. The broader discussion of whether societal resources devoted to improving health are in most highly valued use may seem too abstract and almost irrelevant to their pressing clinical and managerial decisions. These fundamental differences in perspectives will continue to create tension and a potential for misunderstanding between practitioners of CBA and CEA.

4. Using QALYs as a Source of WTP Estimates

This section discusses presents a simple framework that demonstrates how the health economics research on QALYs can be used to fill in gaps in the research on WTP for health improvements. The approach is in the Paretian tradition of applied welfare economics. Other research in this tradition has taken the approach of using estimates of the value of a statistical life (VSL) to "monetize the QALY," (Hirth et al. 2000; Miller et al. 2002; Tolley et al. 1994). Before turning to my framework to "QALY-fy the VSL," I briefly discuss why this previous approach is not entirely satisfactory.

To monetize the QALY previous studies regard the VSL as the present discounted value of future QALYs. It should be recalled that the VSL is a convenient way to summarize or aggregate WTP for small changes in mortality risks. For example, if each person in a population of 100,000 is willing to pay $20 a year for a 0.00001 reduction in mortality risks, the total WTP is $2 million for an annual risk reduction that can be expected in the statistical sense to save one life. In this case, $2 million is said to be the value of a statistical life (VSL). More formally, let WTP for a marginal risk reduction be given by dY/dp, the marginal change in income (Y) that compensates for a marginal change in p. Then the VSL = $[dY/dp]$/p. To relate this to the value of a QALY, Hirth et al. (2000) assume that:

$$\sum_{t=0}^{t=T} \frac{x(QALY_t)}{(1+r)^t} = VSL \quad \frac{dY/dp}{p} \tag{1}$$

With assumptions about the fraction of a quality-adjusted life year the individual enjoys at time t ($QALY_t$), life expectancy (T), the discount rate (r), and the VSL, these authors then derive x, which they call the monetary value of a QALY. An immediate problem with Equation (1) is that it is hard to reconcile the implied profile of VSL and age with theoretical predictions and empirical evidence (Jones-Lee et al. 1985; Krupnick et al. 2002; Shepard and Zeckhauser 1982). And although x is well-defined by Equation (1), it is less clear how it relates to a WTP measure derived from a model of individual preferences. In such a model, there are multiple expressions corresponding to different meanings of the "value of a QALY." Issues include the timing of the QALY loss and whether it occurs with certainty or probabilistically. A useful direction for future work is to explore the conditions necessary for the value x as defined in Equation (1) to correspond to a precisely defined WTP-based measure of the value of a QALY.[7]

Rather than exploring Equation (1), in this section I emphasize a different link than considered in most previous work. I show how QALY estimates can be combined with estimates of the VSL to yield estimates of WTP for morbidity risk reductions. In this way, instead of "monetizing the QALY", I propose "QALY-fying the VSL." The link I emphasize is related to the discussion of the risk–risk approach (O'Connor and Blomquist 1997; Viscusi et al. 1991) and Dolan et al.'s (1995) and Johansson's (1995) comparison of the risk–risk approach and the standard gamble method in the QALY literature. Although it may not be unknown, to my knowledge the link I emphasize has not been previously made explicit.

The approach is to consider WTP for change in mortality risk (p) and morbidity risk (s) in a simple one period expected utility model. The one period is interpreted as "the rest of the consumer's life:" the model does not consider length of life except for the extreme case that with probability p length of life is zero.[8] The consumer derives utility from income (Y) and health, which will be simplified to two states – healthy (H) and sick (S). Her expected utility is therefore given by:

$$EU = (1 - p)[(1 - s)U(Y, H) + sU(Y, S)] \tag{2}$$

The consumer's WTP for pure mortality risk is the marginal change in income that keeps expected utility constant when mortality risk changes. Taking the total derivative of Equation (2) and setting $dEU = 0$ to hold expected utility constant, after re-arranging yields the WTP expression:

$$dY/dp = \frac{[(1 - s)U(Y, H) + sU(Y, S)]}{(1 - p)[(1 - s)U'(Y, H) + sU'(Y, S)]} \tag{3}$$

Similarly derived, the consumer's WTP for pure morbidity risk is the marginal change in income that keeps expected utility constant when morbidity risk changes:

$$dY/ds = \frac{(1 - p)[U(Y, H) - U(Y, S)]}{(1 - p)[(1 - s)U'(Y, H) + sU'(Y, S)]} \tag{4}$$

Combining Equations (3) and (4), the ratio of WTP for morbidity risk to WTP for mortality risk is:[9]

$$\frac{dY/ds}{dY/dp} = \frac{(1-p)[U(Y,H) - U(Y,S)]}{[(1-s)U(Y,H) + sU(Y,S)]} \tag{5}$$

The key insight to link this with QALYs is to recognize that QALY research focuses on a term in the numerator of Equation (5): the difference between utility when healthy – $U(Y, H)$ – and utility when sick – $U(Y, S)$.[10] Consider first a QALY weight q measured using the standard gamble approach. In the standard gamble approach, respondents are asked to consider a hypothetical choice between the certainty of continued life in the sick state, versus a gamble. The gamble has two possible outcomes: a state of optimal health versus death (with a utility or weight of 0.0). The probabilities in the gamble are systematically altered until the respondent is indifferent between the choice of a certain, suboptimal health and the gamble. The expected value of the gamble is the utility or preference weight for the suboptimal health state. That is, if q is the QALY weight it satisfies:

$$qU(Y,H) = U(Y,S) \tag{6}$$

It is somewhat controversial whether QALY weights from other measurement approaches should be viewed as providing cardinal measures of utility that satisfy Equation (6). One view is that other approaches such as the time tradeoff and the visual analogue scale yield QALY weights that approximate standard gamble weights, although differences in empirical values are noted.[11] The time tradeoff approach also directly implies Equation (6) under restrictive assumptions about lifetime utility. In the simple one period model used so far, the length of life has been treated as fixed. Suppose instead that lifetime utility is the product of the length of life (T) and utility from income and health.[12] In the time tradeoff approach, respondents are asked to consider a hypothetical choice between a duration of life of T_1 in the sick state versus a shorter duration T_2 in the healthy state. The length of healthy life is varied until the respondent is just indifferent between T_1 years in the sick state and T_2^* years in the healthy state: $T_1\ U(Y, S) = T_2^*\ U(Y, H)$. This implies a QALY weight $q = T_2^*/T_1$ that satisfies Equation (6).

Substituting (6) into (5) yields[13]

$$\begin{aligned}\frac{dY/ds}{dY/dp} &= \frac{(1-p)(1-q)U(Y,H)}{(1-s+sq)U(Y,H)} \\ &= \frac{(1-p)(1-q)}{(1-s+sq)}\end{aligned} \tag{7}$$

Letting $w = (1-p)/(1-s+sq)$ and re-arranging yields

$$dY/ds = (1 - q)w\,dY/dp. \tag{8}$$

The term w is almost equal to 1 for many plausible parameters (especially as long as the probabilities involved, i,e., p and s, are small). For example, if $p = s = 0.0001$, and life with chronic bronchitis is given a QALY weight of 0.7, $w = 0.9999$. Using these parameters in Equation (8), the value of changing the risk of chronic bronchitis is worth 0.29997 the value of changing the risk of death. Aggregating up to the population level, Equation (8) means that the value of a statistical case of an illness that causes a loss of $(1 - q)$ QALYS is approximately equals $(1 - q)$ times the value of a statistical life. For example, with the assumed parameters, the value of preventing a statistical case of chronic bronchitis is worth about 0.3 VSL.

Equation (8) provides a simple expression derived from a model of individual preferences that can be used to estimate WTP to reduce a wide range of morbidity risks. Given the relatively few existing morbidity valuation estimates from other approaches (Dickie and Gerking 2002), this approach addresses an important gap in the health WTP research literature. The next section illustrates the approach and discusses some limitations.

5. Challenges When Using QALYs for WTP

To begin to explore the practical usefulness of the proposed method to use QALYs to estimate WTP for morbidity risks, this section begins with several examples to illustrate the approach. First, suppose that for a CBA of an environmental policy that improves urban air quality, the analyst needs an estimate of the value of reducing the risk of *angina pectoris* (chest pain). The Beaver Dam Health Outcomes Study provides QALY weights for *angina*, as well as 27 other conditions (Fryback et al. 1993). The QALY weights were derived from time tradeoff questions where the chronic condition would be present for respondents' remaining life expectancy, so the QALY weights can be viewed as satisfying Equation (6) as discussed above. Based on responses from 1253 respondents who had not experienced the condition, the average QALY weight for *angina*is 0.865, with a 95% confidence interval for the mean of (85.2, 87.8). These estimates imply that *angina* involves a QALY loss of about 0.14, so the value of reducing the risks of *angina* is about 0.135 times the VSL. The U.S. EPA (1997) suggests that a reasonable estimate of the VSL has a mean of \$4.8 million with a confidence interval of plus or minus \$3.2 million (in 1990\$). This implies an average value of a statistical case of *angina* of \$648,000 (in 1990 \$), or \$923,000 updated to 2004\$.

A second example illustrates a somewhat different approach to QALY weights. Instead of QALY weights for a specific medical condition, Dolan et al. (1996) estimate QALY weights for six health states that differ along five dimensions: mobility; self-care; usual activities; pain/discomfort; and anxiety/depression. For example, the health state (11,122) involves no problems with mobility, self-care, or usual activities, but moderate pain and discomfort combined with moderate anxiety and depression. Such a health state might correspond to life after an injury from an occupational or traffic accident. Standard gamble and time tradeoff questions were used to derive QALY weights, where "respondents were asked to imagine that each state would last for 10 years without any change and then they would die." (Dolan et al. 1996, p. 215).[14] Viewing the QALY weights from the standard gamble approach as most directly satisfying Equation (6) above, the QALY weight for the health state (11,122) is 0.70, with an interquartile range of 0.45–0.90. Combined with the EPA mean estimate for the VSL, this implies that the value of a statistical accident that results in such a health state is 0.30 times \$4.8 million = \$1.44 million (1990\$), or \$2.05 million (2004\$).

Bell et al. (2001) review 949 QALY weights from the Harvard Catalogue of Preference Scores. As in the examples just provided, in principle it would seem possible to combine these estimates with estimates of the VSL, yielding estimates of the value of a statistical case of each of the 949 conditions. In practice, there are a number of limitations, many of which trace back to the underlying differences in the purpose and intellectual tradition of QALY studies compared to WTP studies.

Because the purpose of many QALY-based CEA studies is to help evaluate clinical interventions, many of the available QALY weights may not be relevant for the types of public policy questions considered in WTP-based CBA. For example, in addition to QALY weights for life with *angina*, other QALY weights related to the diagnosis and treatment of heart disease, such as cardiac catherization, bypass graft surgery; and the side effects of anti-arrythmic drugs. Only an extremely comprehensive CBA of an air quality change that reduced the risk of heart disease would include the value of the utility losses from the treatment for heart disease. An additional consideration is that in many of these cases, the QALY weights are for a temporary condition rather than the rest of the patient's life. This means that even if they were relevant to a WTP-based CBA, it would be inappropriate to use the method proposed above to combine such QALY weights with the VSL.

The difference in intellectual traditions between QALY-based CEA and WTP-based CBA often shows up in ongoing disputes about CEA methods. One area of dispute concerns what is in a QALY and what should be in a QALY. The model in Section 4 assumes that the QALY weight reflects the full difference between utility in perfect health and utility in less-than-perfect health state. Although suppressed in the simple model above, the utility difference will reflect changes in income, leisure, and future health care costs that are associated with different health states. However, these changes are not explicitly mentioned in many of the surveys or experiments used to measure QALYs. As a result, it is unclear whether respondents have in fact incorporated them into their stated preferences over health states. In at least one commonly instrument to measure QALYs the instructions are explicitly inconsistent with the model of Section 4: "the Health Utilities Index, explicitly instructs individuals being interviewed to assume that their financial circumstances would ***not*** vary with health status," (Meltzer and Johannesson 1999, emphasis added).

Another area of dispute is whose preferences should be used to measure QALYs (Dolan 1999, 2000). The model of Section 4 is based on the preferences of an individual who faces a risk of being in a morbid health state. In practice, QALY weights come from a variety of sources. In the catalogue of weights compiled by Bell et al. (2001, Table 2): 23.5% from the community (i.e., people who have not experienced the condition in question); 26.8% of the QALY weights came from patients with the condition; 35.8% from experts/clinicians; and 25.1% from the authors of the CEA studies. (The percentages sum to more than 100% because there were multiple sources for many of the health states valued.) The Panel on Cost-Effectiveness in Health and Medicine recommends that QALY weights should be based on community preferences (Gold et al. 1996), but other practitioners argue for QALYs based on patients' preferences. Experts, clinicians or authors are not viewed as a recommended source, but instead as a pragmatic, easily obtainable and low cost source of QALY weights; presumably the values are viewed as estimates of either community or patients' preferences over health states.

The dispute between using patients versus the community as a source for QALY weights is at two levels. At one level, the dispute is about the tradeoffs involved in measuring an agreed upon concept. On the one hand, patients have actually experienced the morbid health state, so they are more informed about the difference between utility when healthy and utility when sick. On the other hand, patients' reported values might be subject to strategic bias. Whether it is worth accepting the possibility of bias to obtain more informed values is a difficult judgement call that might vary depending upon the condition in question. But at another level, the dispute is deeper: "The panel's principal reason for this recommendation [in favor of community preferences] was that, since the public bears the costs associated with resource-allocation decisions, they ought also to have some say in the determination of benefits." (Dolan 1999, p. 482). This rationale seems to suggest that it might be appropriate to reject patients' preferences over health states even if such preferences are the most accurate measure of the utility loss, which is clearly inconsistent with the individual preference-based model of Section 4.

6. Conclusions

As indicated in the title, this paper provides a mixed message about linking the WTP and QALY approaches to valuing health. In the even-numbered sections of the paper (2 and 4), I emphasize common ground and suggest a way to use QALY results to provide estimates of WTP for a wide range of morbidity conditions. In the odd-numbered sections of the paper (3 and 5), I discuss differences between the approaches that make linking them more difficult. Along the way, I have also pointed out a number of issues that deserve more attention in future work. The challenge for future work is to exploit the "gains from intellectual trade" between these two research literatures while recognizing important barriers to trade.

Notes

1. CEA that uses QALYs or related preference-based measures of effectiveness is also known as cost-utility analysis.
2. I also recognize that many researchers will have deep expertise in at least one of the approaches. so I acknowledge the limitations of the brief overview of issues provided. For additional discussion, see Freeman (2002) and Hammitt (2002a).
3. The OMB guidelines discusses QALYs as one measure of effectiveness but explicitly "does not require agencies to use any specific measure of effectiveness." (OMB 2003, p. 13). This appears to be a reaction to criticisms that the QALY approach may discriminate against persons with disabilities. The guidelines are careful to advise that "For example, if QALYs are used to evaluate a lifesaving rule aimed at a population that happens to experience a high rate of disability... the number of life years saved should not necessarily be diminished simply because the rule saves the lives of people with life-shortening disabilities." (OMB 2003, p. 13)
4. Standard textbooks such as Drummond et al. (1997) elaborate on how these simplified decision rules are applied in more complicated situations, such as CBA when interventions are mutually exclusive, or CEA and the concepts of simple and extended dominance.
5. Other countries appear to place a somewhat lower value on a QALY. Somewhat oddly, in the Canadian context Laupacis et al. (1992) suggest exactly the same nominal cutoff values as Kaplan and Bush (1982). Adjusted for inflation and the exchange rate between the US$ and Canadian$, the recommendations of Laupacis et al. (1992) imply a cutoff value of US$64,000 (Gryd-Hansen 2003). George et al.'s (2001) analysis of decisions of the Australian Pharmaceutical Benefits Advisory Committee suggests the Committee implicitly used a cutoff value of about US$40,000. England's National Institute for Clinical Excellence appears to implicitly use a cutoff value of £20,000 to £30,000 per QALY as a rough rule of thumb, which at the current exchange rates implies a cutoff value around US$36,000 to US$54,000.
6. CEA eventually played a smaller role in the process. After a series of legal challenges, the Clinton Administration approved a revision of Oregon's plan where the primary criterion for priority is the ability of the treatment to prevent death, while average cost of treatment can be considered as a tiebreaker.
7. This could build on the results of Garber and Phelps (1997), Bleichrodt and Quiggin (1999), Hammitt (2002a, b), Klose (2003), and Dolan and Edlin (2002) on WTP for a QALY.

8. Rosen (1988, 1994) develops expressions for WTP for health in a model where both quality and quantity (length) of life can vary. Obviously, the one period model here sidesteps these complications.
9. The right hand side of Equation (5) is also a version of the marginal risk-risk tradeoff, dp/ds, i.e., the marginal change in mortality risk p that keeps expected utility constant when morbidity risk increases.
10. An anonymous referee points out that in Equation (2), the healthy state H is best interpreted as "ordinary health" without the chronic condition. In contrast, in many QALY studies respondents are asked about their preferences between "perfect health" and life with a chronic condition. To the extent that ordinary health falls short of perfect health, QALY studies will overstate the loss of health and utility due to a chronic condition.
11. Some evidence suggests that the standard gamble approach yields larger QALY weights than the time tradeoff approach; for more discussion see Dolan et al. (1996).
12. Culyer and Wagstaff (1993, p. 313) describe this functional form as an "implicit assumption" that underlies the time tradeoff approach. Dolan and Jones-Lee (1997) consider the interpretation of responses to time tradeoff questions under more general descriptions of lifetime utility.
13. This substitution is valid for a QALY weight measured using the standard gamble approach, or for a QALY weight measured using the time tradeoff under the assumption that lifetime utility is the product of the length of life and utility from income and health. As long as the duration of life is the same across health states, the ratio of WTP for morbidity risk to WTP for mortality risk will still be given by expression (5) under the assumption about lifetime utility.Note that the assumption that the duration of life is the same across health states concerns the actual description of life with the chronic condition, not the hypothetical choice presented in the time tradeoff approach.
14. Because respondents are asked to imagine that they experience the condition for the rest of their lives, this approach is consistent with the model in Section 4 of expected utility over the rest of life. However, respondents were also asked to imagine a specific life expectancy – 10 years. To the extent that VSL and QALY estimates are sensitive to remaining life expectancy, it may be problematic to use the estimates from Dolan et al. (1996) to estimate WTP.

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