Valuing health: An examination of the theoretical and empirical issues

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1. Introduction

It has been proposed that estimation of the societal willingness to pay (WTP) per quality adjusted life year (QALY) gained should be a research priority in health economics (Johannesson and Meltzer 1998). Several methodologies have been described to perform this valuation (Kenkel 1997, Stinnett and Mullahy 1998). In this paper, we examine the theoretical basis of health economic analysis, and explore what implication the underlying theory has for valuing QALYs, and for valuing health benefits in general.

In Section 2 of the paper, we will examine the differences between the QALY-based approach and the WTP-based approach for valuing health benefits. We will also examine the implications of adopting the extra-welfarist perspective and discuss the appropriate population to survey to value health benefits.

In Section 3 we examine the issues involved in estimating the value of a QALY from a welfare economics perspective in greater detail. In Section 4 of the paper we will examine more closely the different methodologies that can be used to elicit WTP for a new interventions. We propose conjoint analysis as an alternative to the contingent valuation (CV) methodology for valuing WTP, and examine the advantages of using the conjoint analysis methodology. We also present the results of two pilot studies that used conjoint analysis to estimate WTP for health benefits

2. Computing net benefit: WTP vs QALYs

We will first examine a welfare economics based evaluation of health interventions, which requires the valuation of the costs and benefits of the interventions at the individual level. These individual utility functions are then aggregated to obtain a

social welfare function. A strict utilitarian approach whereby the social utility is formulated as the sum of individual utilities is commonly used, even though welfare economics does not dictate such an aggregation function. See Culyer and Evans (1996) for a detailed critique of the formulation where societal net benefit is expressed as a sum of individual consumer surplus.

The evaluation methodology that is most closely rooted in welfare economics is the WTP approach. In this approach, if the total monetary amount that individuals in the society are willing to pay for the benefits of a new intervention compared to the old one exceeds its incremental cost, the new intervention is considered worth implementing.

Let us consider an intervention A which is both more effective and more expensive than another intervention B. Let W_i be individual i's WTP for having A rather than B, and let C be the cost that each member of society would have to pay if A is used rather than B. The WTP approach would state that A should be adopted if

$$\Sigma_i W_i / N > C \qquad (1)$$

where N is the number of individuals. If the condition in equation 1 is met, the decision to adopt A can be justified based on the compensation test, whereby the winners would be willing to compensate the losers enough to result in a pareto improvement (see Culyer and Evans (1996) for criticisms of the compensation test).

An alternate methodology for evaluating health interventions, as proposed by the cost-effectiveness panel (Gold et al. 1996), measures the incremental health benefit of a new intervention in terms of average QALYs gained compared to the current intervention. Since the panel recommends that the QALY-approach also be based in

welfare economics (Garber 1996), the average QALYs gain should be computed based on valuations placed by the general population on the health states involved. The intervention is determined to be "cost-effective" from a societal perspective if the incremental cost of achieving a gain of one QALY falls below a threshold societal value per QALY gained. As shown by Laska et al. (1999), this is equivalent to examining whether the benefits in monetary terms exceed the costs, where the societal value per QALY is used to convert the QALY gain into monetary units.

Let Q_i be the QALY gain derived by individual i from the incremental health benefits of A compared to B, and let V_i be individual i's monetary value per QALY. The QALY-approach would use the average QALY gain of A compared to B and the average value per QALY to examine whether the incremental benefit of A compared to B exceeds its incremental costs. Hence, the QALY-approach makes the following comparison:

$$(\Sigma_i Q_i / N) * (\Sigma_i V_i / N) > C \qquad (2)$$

The existence of two approaches — the WTP-based approach and the QALY-based approach — for evaluating health interventions raises the question whether they are equivalent, and if so under what conditions. Since $W_i = Q_i \times V_i$, we can rewrite equation 1 as

$$\Sigma_i (Q_i \times V_i) / N > C \qquad (3)$$

It is clear that the criterion provided by the QALY approach (equation 2) and the criterion provided by the WTP approach (equation 3) will not be identical unless either Q or V is the same for all individuals.

The valuation of a health state in the QALY approach is affected both by the person's perception of the health state and the person's value for years of life. Thus, a high time tradeoff (TTO) score could mean either that the individual values the health state highly, or that the individual values years of life highly and is unwilling to give up length of life to improve quality of life. If the value of a year of life varied widely across individuals, we would expect a low correlation between quality of life profile scores and TTO values. This has been found to be true in practice by several researchers (0.44 (7), 0.28 (8)). The variation in value per QALY across individuals implied by these empirical results indicate that the QALY-based and WTP-based approach are unlikely to lead to identical allocation criteria for health care resources.

The extra-welfarist perspective

The welfare economics based approach has been critcized by economists for ignoring distributional issues (Culyer and Evans 1996). The main criticism that has been raised regarding the welfarist approach is that it could lead to health care resources being distributed away from individuals who place a relatively low value on health, potentially due to their inability to pay for it (Wagstaff 1994). Further, the hypothetical compensation on which the welfare economics results are based does not take place in reality.

An alternative to the welfarist approach is the extra-welfarist model. The objective of this model is to maximize health within the available budget, and not maximize consumer surplus. In such a model, the value of a unit of health (say QALY) is

by definition identical for every individual in society. Further, the QALY-weights for a health state are identical across individuals.

In the welfarist model the societal value of a health benefit is obtained by aggregating individual benefits. Societal valuation of health benefits in the extra-welfarist approach is not necessarily based on individual valuations of these benefits. In the extra-welfarist approach, valuations can be obtained from decision makers who are in turn responsible to the rest of society. This raises the question, who is the appropriate population to survey for valuing health benefits? Welfare economics would dictate that the valuation should be based on surveying a sample of the general population. The extra-welfarist model would not recommend such a survey based on the argument that this could result in diversion of resources away from individuals who do not place a high value on health. The extra-welfarist model might prefer valuations made by a decision maker whose objective is to maximize society's health.

3. Estimating the monetary value of a QALY

If the population is relatively homogeneous in their valuation of life or in their willingness to trade-off quantity for quality of life, we could use the QALY methodology to estimate the societal benefit of health interventions. From a welfare economics perspective, the societal value per QALY is a function of individual valuations of a QALY. In general, an average of individual valuations is used as the societal value, due to problems associated with differentially weighting individuals.

Even under this scenario, we face considerable empirical challenges in estimating the societal value of a QALY gained. Underlying the attempt to value a QALY is the

assumption that a QALY is a uniquely quantifiable health benefit that can be communicated to an individual. In other words one QALY is identical to any other QALY. As we will discuss below, there is little empirical evidence to support this assumption.

Let us consider asking an individual for their WTP for improvements in an acute condition, such as pain of a dental procedure, as well as health gains in a chronic condition, such as arthritis. There is no evidence that the value of a QALY implied by the responses to the two questions will be similar. Thus, the disease scenario (acute or chronic) that is presented in valuing a QALY could substantially influence the value per QALY that is elicited.

In the QALY methodology gains and losses in QALYs are valued identically. Descriptive models of individual behavior, such as prospect theory (Kahnemann and Tversky 1979) indicate that individuals might value losses more highly than gains. This is reflected empirically in the fact that for the same good, willingness to accept studies usually yield higher values than WTP studies. This implies that studies that examine health gains might yield a different value of a QALY than studies that examine loss in health.

QALY methodology also assumes a constant marginal value of a QALY. Thus the value of gain of two QALYs is assumed to be twice the value of one QALY. This assumption also allows the QALY methodology to ignore distributional issues, since the societal WTP will be identical regardless of whether the health gain is experienced by one individual, or whether it is distributed across several individuals. Once again there is no evidence that the constant marginal value assumption holds in practice, and hence the

magnitude of the health benefit used in the study could affect the estimated value of a QALY.

4. Estimating WTP

There are two main approaches to estimating the WTP for a health benefit – the revealed preference approach and the stated preference approach. The revealed preference approach estimates WTP based on observed behavior. Thus, the value of a health benefit may be inferred from difference in property costs across regions with different amounts of pollution, or from wage premiums for hazardous jobs. In practice, observational data to estimate such WTP is often difficult to obtain.

The more commonly used approach for estimating WTP is the stated preference approach. In this approach, the WTP is estimated from responses to survey questions in which respondents are asked to evaluate hypothetical scenarios. The most commonly used stated preference technique is contingent valuation (CV), where the respondent is asked to state their WTP for a good, contingent on the existence of a market for that good. One drawback of the CV methodology is that it can be used to evaluate the WTP for only those goods that were included in the survey. In contrast the QALY methodology can be used to value many different health improvement scenarios, once the QALY-weights of the health states involved have been estimated.

An alternate stated preference approach that can be used to value health benefits is conjoint analysis (Ryan and Hughes 1997). In conjoint analysis individuals are asked to value goods that are presented as composites of several different attributes. The responses are then used to estimate how the individual's utility for the good is affected by

the product attributes, one of which could be price. The conjoint analysis results will now allow us to estimate the WTP for any health improvement scenario that can expressed as a combination of the attributes used in the study. This ability of conjoint analysis to evaluate scenarios that were not explicitly used in the study makes it more flexible than CV. Beyond valuing attributes of new interventions, the conjoint analysis results can be of use to researchers in identifying directions for future drug development. For instance, it might inform the researcher what rate of adverse events might be acceptable for a given magnitude of clinical benefit, and how much societal decision makers would be willing to pay for that benefit.

The process of conducting a conjoint analysis study can be divided into five discrete steps (i) define product attributes and levels; (ii) design conjoint analysis survey instrument; (iii) draw sample and administer survey; (iv) estimate utility function; and (v) interpret and use results. We briefly describe below each of the five steps. We then present results of two pilot studies that we conducted in using conjoint analysis to value health benefits.

Defining product attributes and levels is probably the most important step in conducting a conjoint analysis study. The product attributes are used to describe the health benefit that we are interested in valuing. In depth interviews and focus groups are usually used to pare down an exhaustive list of attributes to a more manageable number (usually 6-10). The levels of each attribute are values that the attribute can take on in the conjoint survey. These levels are chosen to cover the range of benefits that we are interested in examining.

The conjoint survey is based in experimental design. In our pilot studies we used designs based on an orthogonal array, which allows attribute weights to be estimated without confounding. We assumed that there were no interactions between attributes; that is the value of one attribute does not affect preference for another attribute. Various types of questions, such as full profile questions, paired comparison questions, or choice questions can be used to elicit responses in a conjoint survey. In our pilot survey we used a full profile approach, where respondents were asked to evaluate a drug profile and state their likelihood of using the drug on a 1 to 9 scale. An example of a survey question for acute myocardial infarction (AMI) is shown in Figure 1.

Once the survey design is complete, the next step is to draw a sample and administer the survey. At this juncture we need to decide whose WTP we would like to elicit. As noted in Section 2, the WTP approach has in the past been closely associated with welfare economics, where a representative sample of the general population is surveyed. However, WTP can also be used from a extra-welfarist perspective to determine how much of their constituents premiums or tax dollars health care decision makers are willing to spend on specific health improvements. In our pilot study we surveyed decision makers to attempt to answer precisely this question.

A regression model is used to estimate the relative utility weights of the levels of each attribute. We used an OLS model to estimate the utility function. Models for categorical dependent variables such as logit and probit can also be used to account for the discrete nature of the responses.

The conjoint analysis methodology is commonly used in market research to simulate different market scenarios and predict market shares for these scenarios.

From a health economic perspective the conjoint analysis results can be used to estimate the WTP for an improvement in any health attribute included in the study. For example, assume that a $1 increase in drug cost decreases the decision maker's utility of the drug by ΔP. Let a 1% decrease in mortality increase decision maker's utility by ΔM. Then, the decision maker's WTP for 1% decrease in mortality is given by $\Delta M/\Delta P$. We now present the results of two pilot studies in which we examined health care decision makers' WTP for improvements in different health attributes.

AMI

The attributes and levels used in the conjoint analysis study are shown in Table 1. Figure 1 shows example of a question posed to the respondent. As part of the pilot study the conjoint survey was administered to eleven decision makers (6 clinical cardiologists, 2 emergency department physicians, and 3 pharmacy directors) in the U.S.

The responses to the conjoint questions were used in an OLS model to estimate the group's utility function (Table 2). One interesting finding was that the a dollar increase in annual cost of care affected the utility function much less than a dollar increase in drug cost. One potential reason for this could be that in the U.S these decision makers are not responsible for annual cost of care. Another potential reason could be that they view annual cost of care with skepticism, due to the assumptions involved in estimating such a cost.

The study estimating a WTP of $820 for a decrease in mortality of 1% at 30 days. If we assume that a 1% decrease in mortality results in a QALY gain of 0.15, this would imply a value per QALY of $5,467. This value is much smaller than the value per QALY

generally used to evaluate health interventions (Kupersmith 1995). It has to be noted that the result is based on a survey of just eleven decision makers. All the same, the results raise questions regarding whether current mortality rate of a disease and the current expense of treating it could affect the decision maker's value for incremental clinical improvements.

Asthma

The attributes and levels used in the conjoint analysis study are shown in Table 3. As part of the pilot study the conjoint survey was administered to twelve decision makers (6 pharmacy directors, 2 medical directors, and 4 other). The responses to the conjoint questions were used in an OLS model to estimate the group's utility function (Table 4).

Based on the estimation results, the decision makers were willing to pay $0.32 per day for 1% change in FEV1. If a 1% change in FEV1 increases the QALY by 0.01 over a one year period, this would imply a value per QALY of $11,741. If the QALY improvement were larger the value per QALY would be lower, and vice-versa.

6. Summary

In this paper we examined some of the theoretical and empirical issues involved in valuing health benefits. Welfare economics has been proposed as the theoretical foundation for conducting cost-effectiveness studies of health interventions (Garber et al. 1996). The methodology for valuing health benefits that is most closely based on welfare economics is the WTP approach (Kenkel 1998). We showed in this paper that the QALY-based approach of valuing health benefits would differ from the WTP-based

approach if individuals differed in their valuation of health states, or in their monetary valuation of years of life.

Even if individuals can be assumed to be homogeneous, the QALY based approach still requires an estimate of the monetary value per QALY. We described some of the problems associated with valuing a QALY, the most important being that individuals may not value QALYs defined under different disease scenarios identically. Thus, to establish that we can obtain a reliable estimate of the value of a QALY, we must first empirically show that the definition of a QALY used in the elicitation exercise does not affect this value.

We explored the question of whose value of health benefit should be used in health economic analyses. From a welfare economic perspective societal value of health benefit is determined by valuations of individuals in the society. However, the welfare economic model has not found universal acceptance among health economists (Culyer and Evans 1996). If we adopt the extra-welfarist perspective, valuation of health benefits provided by societal decision makers may be appropriate to use in economic analyses.

We also described different means of valuing the WTP for a health benefit. Conjoint analysis provides a more flexible approach to valuing health benefits than the more commonly used CV technique, since conjoint analysis allows us to determine the WTP for products that were not directly evaluated in the study. We illustrated the use of conjoint through pilot studies for a new AMI treatment, and a new asthma treatment. The results of the study raised some questions regarding value per QALY that is traditionally used in economic analyses.

In summary, significant theoretical and empirical hurdles remain before we can reliably estimate the value of a QALY and use it for recommending allocation of healthcare resources. The WTP methodology avoids the two stage procedure introduced by the QALY methodology, where health benefits are first valued in terms of mortality (or years of life) and are then converted to monetary units based on the value of year of life. This paper underscores the need for further empirical work in QALY and WTP elicitation to examine which methodology and whose values will provide a more useful basis for evaluating new interventions and developing new therapies that will increase societal welfare.

References

Johannesson, M. and D. Meltzer, 1998, Some reflections on cost-effectiveness analysis, Health Economics, 7, 1-7.

Kenkel, D., 1997, On valuing morbidity, cost-effectiveness analysis, and being rude, Journal of Health Economics, 16, 749-757.

Stinnett, A.A. and J. Mullahy, 1998, A new framework for the analysis of uncertainty in cost-effectiveness analysis. Med Decis Making; 18 suppl:S68-S80.

Culyer, A.J., and R.G. Evans, 1996, Mark Pauly on welfare economics: Normative rabbits from positive hats. Journal of Health Economics; 15:243-251.

Gold, M.R., J.E. Siegel, L.B. Russell, and M.C. Weinstein, eds, 1996, Cost-effectiveness in health and medicine (Oxford University Press, New York).

Garber, A.M., M.C. Weinstein, G.W. Torrance, and M.S. Kamlet, 1996, Theoretical foundations of cost-effectiveness analysis. In: Gold MR, Siegel JE, Russell LB,

Weinstein MC Eds. *Cost-Effectiveness in Health and Medicine*. New York, NY. Oxford University Press:247-275

Laska, E.M., M. Meisner, C. Siegel, and A.A. Stinnett, 1999, Ratio-based and net benefit-based approaches to health care resource allocation: Proofs of optimality and equivalence, Health Economics, 8, 171-174.

Wagstaff A., 1994, QALYs and the equity-efficiency tradeoff, In Cost-benefit analysis (Cambridge University Press): 428-447.

Kahneman, D., and A. Tversky, 1979, Prospect theory: An analysis of decision under risk. Econometrica; 47:263-291.

Ryan, M., and J. Hughes, 1997, Using conjoint analysis to assess women's preferences for miscarriage management, Health Economics; 6:261-273.

Kupersmith, J., M. Holmes-Rovner, A. Hogan, D. Rovner, and J. Gardiner, 1995, Cost-effectiveness analysis in heart disease, Part III: Ischemia, congestive heart failure, and arrhythmias, Progress in Cardiovascular Diseases; 37:307-346.

Table 1: Attributes and levels for AMI conjoint analysis survey

Attribute	**Levels**
30 day mortality	• 6.3% • 5.3%
Patency at 60 minutes	• 84% • 74%
Rate of reinfarction	• 3% • 4%
Rate of stroke	• 1.55% • 2.05%
Drug Cost	• $2,300 • $2,700
Annual Cost	• $26,690 • $27,190

Table 2: Results of OLS model for AMI

Attribute	Coefficient	P-value	Marginal WTP for a 1% change
Intercept	-0.0458	0.864	
30 day mortality	1.6694	<0.001	$820
Patency at 60 minutes	0.0518	0.089	$25
Rate of reinfarction	0.6088	0.046	$299
Rate of stroke	-2.6613	<0.001	$1,307
Drug Cost	-0.0020	0.004	
Annual Cost	0.0006	0.364	

Table 3: Attributes and levels for asthma conjoint analysis survey

Attribute	**Levels**
Drug cost per day	• $2.50 • $5.00
Change in Fev1	• 15% • 30%
Short term adverse event rate	• 5% • 10%
Long term adverse event rate	• 5% • 10%
Mode of administration	• oral • inhaled

Table 4: Results of OLS model for asthma

Attribute	Coefficient	P-value	Marginal WTP for a 1% change (except for mode of administration)
Intercept	-0.9480	0.001	
Drug cost per day	-0.4468	<0.001	
Change in Fev1	0.1437	<0.001	$0.32
Short term adverse event rate	-0.0052	0.930	$0.01
Long term adverse event rate	-0.0870	0.144	$0.19
Mode of administration (oral vs inhaled)	0.3575	0.295	$0.80

Figure 1: Example of conjoint question for AMI