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IS IT REALLY POSSIBLE TO BUILD A BRIDGE BETWEEN COST-BENEFIT ANALYSIS AND COST-EFFECTIVENESS ANALYSIS?

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ABSTRACT

Cost-benefit analysis (CBA) is recognised as the economic evaluation technique that accords most with the underlying principles of standard welfare economic theory. However, due largely to problems associated with the technique, economists evaluating resource allocation decisions in health care have most often used cost-effectiveness analysis (CEA), in which health benefits are expressed in non-monetary units. As a result, some economists have attempted to build a welfare economic bridge between CBA and CEA. It has been suggested that an article by Pratt and Zeckhauser (1996) "provides the strongest theoretical justification to date" for such a bridge (see Johannesson and Meltzer 1998). In this paper, we develop Pratt and Zeckhauser's model to show that while assumptions can be made to facilitate a constant willingness-to-pay (WTP) per unit of health outcome, these restrictions appear highly unrealistic when life expectancy, health status and variable incomes are incorporated into the model. We conclude that, within a welfare economic framework, it would be unwise to use CEA and a constant WTP per outcome unit in economic evaluations.

Key Words: economic evaluation, cost-benefit analysis, cost-effectiveness analysis, willingness-to-pay, quality-adjusted life-years

JEL Classification: I10

INTRODUCTION

Many economists have advocated the use of cost-benefit analysis (CBA) when evaluating the allocation of public sector resources (see Mishan 1988). CBA is seen to be firmly located within standard welfare economic theory, not least because it considers the preferences of the individuals affected by government decisions to be of central importance. Under CBA, the preference measure is a function of whatever individuals consider to be important and, in this welfarist sense, no greater moral status is attached to one kind of preference as compared to another. Evaluation requires the costs and benefits derived by the community from any given programme to be expressed in a common (normally monetary) unit, so that the sign of the net benefit can be used as a decision criterion. CBA aims to maximise aggregate welfare and so it is the only methodology that, at least in theory, provides information on the absolute benefit of different programmes.

Other economists, perceiving ethical and/or methodological problems in attaching a monetary value to non-market benefits (see Hausman 1993), have advocated the use of alternative methods of measuring the benefits of public programmes. In the evaluation of health care, for example, economists have developed cost-effectiveness analysis (CEA) which attempts to express the benefits from different health care programmes in a single health-related measure, such as gains in life years or quality-adjusted life-years (QALYs).[1] Indeed, the majority of economic evaluations of health care interventions that have been conducted around the world have been CEAs rather than CBAs (see Elixhauser *et al* 1993).

In essence, CEA considers only health-related measures of benefit to be relevant. This has led Kenkel (1997) to conclude, "when we accept the methodology of welfare economics, we should use cost-benefit analysis, not cost-effectiveness analysis". However, Johannesson (1995) has argued that if all societal costs are included in a cost-effectiveness analysis (CEA) and if a price per unit of outcome is specified as the decision rule, then CEA can be interpreted

[1] We recognise that the literature on economic evaluation often distinguishes between cost-effectiveness analysis, in which benefits are expressed in a single natural unit (such as life years gained), and cost-utility analysis, in which information on length of life and quality of life are combined into a single composite measure (such as QALYs). However, in the context of this paper, it is sufficient to use the term cost-effectiveness analysis to represent both types of analyses.

as a cost-benefit analysis (CBA) where the willingness-to-pay (WTP) per QALY is constant. Linking the two forms of analyses in this way would be appealing to many economists since the results from the ever-increasing number of CEAs could be interpreted within a standard welfare economic framework.

The link between CBA and CEA can be forged either empirically, by showing that WTP-per-QALY does not vary according to context, or theoretically, by showing that individuals ought to have a constant WTP-per-QALY from a welfare economics standpoint. It is in the latter regard that Johannesson and Meltzer (1998, hereafter JM) claim that an article by Pratt and Zeckhauser (1996) "provides the strongest theoretical evidence to date" for the use of a constant WTP-per-QALY figure. This paper considers the prospects of amalgamating CBA and CEA within the framework developed by Pratt and Zeckhauser (hereafter PZ).

WTP AND THE DISTRIBUTION OF RISK AND WEALTH

The PZ model considers the effect of the distribution of risk and wealth on aggregate WTP for reducing mortality risks. Using an expected utility (EU) framework and assuming that death lowers the marginal utility of wealth, PZ isolate two opposing effects that the concentration of risk may have on aggregate WTP. First, the 'high-payment effect' asserts that the smaller a group, the fewer the resources at their disposal, and hence the less the group will be willing to spend on reducing an absolute mortality risk. The high-payment effect considers only the impact of decreasing the resources available to the at-risk group and thus, the more concentrated a given aggregate risk is in a population, the lower will be aggregate WTP. Second, the 'dead-anyway effect' considers the effect of desperation. An individual facing almost certain death obtains little utility from wealth and so is willing to forgo the vast majority of his wealth to reduce his risk. The dead-anyway effect considers the impact of increased risk on those remaining after a risk has become more concentrated and suggest that aggregate WTP increases as risks become more concentrated. Therefore, the two effects work in opposite directions and PZ show that either effect may dominate.

PZ argue that WTP is an appropriate benefits metric in a market economy as both the high-payment and dead-anyway effects are (rightly) present. In a public policy setting, however, the high-payment effect does not exist as society has the same aggregate wealth irrespective of who bears the risk. Therefore, PZ argue that the correct WTP from a societal perspective occurs where all individuals bear the same (expected) risk. In this way, the dead-anyway effect is also zero. To achieve this, PZ place individuals behind a veil of ignorance, thus preventing them from perceiving their risk type and wealth level. Behind such a veil, individuals are assumed to maximise EU (represented by the sum of individual cardinal utilities) in order to determine the optimum level of risk-reducing expenditures (which are financed equally by all individuals).[2]

PZ show that EU maximisation requires that the cost of a marginal decrease in risk is set equal to societal WTP for that same marginal decrease in risk. The first order conditions imply that where wealth is constant across society, individuals will seek to achieve the same expected marginal risk reduction across all risk types. Where wealth differs, the optimal reduction varies negatively with wealth i.e. society places a greater weight on risk reductions for wealthy individuals. PZ argue that before the veil of ignorance is lifted, the relevant measure of expected marginal utility is the value of a dollar to society rather than to any specific individual. By substituting societal expected marginal utility for private expected marginal utility, they correct marginal WTP figures for distortions caused by individuals knowing where they fall in the distribution of risk and wealth.

JM's appeal to PZ is partly an appeal to the veil of ignorance to remove the ability of different groups, when defined according to non-health factors, to display different preferences. The attempt to resolve the theoretical conflict between CBA and CEA is complicated by the fact that PZ assume that health influences the marginal utility of wealth. Behind PZ's veil, society makes decisions by maximising the sum of cardinal utilities. If good health improves the ability to enjoy wealth, then individuals with higher wealth will gain a greater increase in utility from a given health improvement. *Ceteris Paribus*, this suggests that society is willing to pay a higher amount to save the life of a wealthy individual. This violates the assumption of a constant WTP-per-QALY as programmes focusing on the rich would accrue greater benefits to society for an equal number of QALYs than those focused on the poor. To avoid this problem, JM assume that incomes are constant across all individuals. As income is the only

[2] In this way, the veil of ignorance is analogous to the one put forward by Harsanyi (1951) and is a rather 'thinner' veil than that proposed by Rawls (1971).

non-health factor, the problem of interaction between health and non-health factors is resolved. Even though JM's proposed link between CEA and CBA is a theoretical exercise, the problems associated with unrealistic assumptions remain.

SOCIETAL WTP PER QALY

Linking CBA and CEA requires that both forms of analyses produce the same answer in any given evaluation using a net *social* benefit decision rule. The interdependence of utility functions must therefore be incorporated into the model. However, since it is typically assumed that there are no interpersonal aspects to utility, the same assumption will be made here, and so social WTP will correspond to individual WTP as individuals are not concerned with the health of others. This assumption is also made in the article by PZ.[3] In addition, as the monetary benefit cannot vary according to anything not captured by both CEA and CBA, only the health-related measure can be significant under CBA. Therefore, for a valid link to exist between the analyses, non-health factors cannot be permitted to affect WTP. This constrains the form of utility function, preventing interaction between health and non-health factors, such as income.

Incorporating QALYs into the model

PZ's paper considered societal WTP for reductions in mortality risk. JM used this paper to argue for a link between CBA and CEA, even though the concept of a QALY does not appear in PZ's model. In the PZ model, the individual simply lives (for an unspecified period of time in an unspecified health state) or dies. Therefore, JM's claim of a link between CBA and CEA depends not only on the assumption that QALYs are a valid cardinal utility function for individuals (as argued by Johannesson (1995)) but also on the implications of incorporating life expectancy and health status into PZ's model. We now consider those implications.

In extending PZ's model to include length and quality of life, we allow health status to vary by the risk and income type x, distributed according to the relative frequency function f(x). The

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[3] It is worth noting that it is possible to allow for interdependent utility functions but only under certain restrictive assumptions (see Jones-Lee (1992) for an exposition of this).

probability of illness occurring, p(x, e(x)), is based on type and the expenditure society commits towards these individuals, e(x). As in PZ's paper, our model deals with preventative treatment only as the individual remains in whichever health state they emerge in once the veil of ignorance is lifted. In order to consider curative treatments, the model would first have to consider the differential impact that treatment has on individuals. If a curative treatment proves ineffective for an individual, it will not be continued and so the type-dependant expenditure of PZ's model is inappropriate for curative treatments unless compound lotteries are introduced into the model. While it may well be possible to redefine PZ's model to allow expenditures to vary within a type, the applicability and suitability of a generalised veil for assessing curative (or palliative) treatments is not discussed here.

Let health status be H, where death and full health are given values of zero and one, respectively.[4] PZ's state-dependant utility is replaced by a utility function in income and health, $u(w,H)$. It is expected that marginal utility will increase in health, so that:

$$0 < u_w(w,H_0) < u_w(w,H_1) \text{ for all } H_0 < H_1.$$

An individual of type x is assumed to live for L(x) years for certain, at which time they receive utility from the legacy they leave their dependants. This posthumous utility is assumed to be a function of wealth at the time of death. In order to make this analysis consistent with PZ's, this posthumous utility is assumed to be the same level of utility as that associated with a health state judged as bad as death. It is assumed that individuals discount future periods exponentially with a rate of time preference equal to the interest rate.[5] Intertemporal utility for an individual with certain income w, health H, and life expectancy L is therefore equal to:

$$\begin{aligned} U(w,H,L) &= \int_0^L e^{-rt} u(w,H)dt + \int_L^\infty e^{-rt} u(w,0)dt \\ &= \tfrac{1}{r}\left(1-e^{-rL}\right)u(w,H) + \tfrac{1}{r}e^{-rL}u(w,0) \end{aligned}$$

[4] There is no reason why health status need be positive in all circumstances. For illnesses implying a literal 'fate worse than death', H will be negative.

[5] We recognise that there are other discount functions (for example, the hyperbolic one) which may better represent individual preferences, but in order to avoid dynamic inconsistency and to remain within JM's frame of reference, we assume an exponential rate in our analysis.

As the probability of an illness occurring for an individual of type x is p(x, e(x)), expected utility is:

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\begin{aligned}
&EU(w(x), H(x), L(x)) \\
&= p(x,e(x))U(w(x),H(x),L(x)) + (1 - p(x,e(x)))U(w(x),1,L(x)) \\
&= \tfrac{1}{r}\left(1-e^{-rL(x)}\right)u(w(x),1) + \tfrac{1}{r}e^{-rL(x)}u(w(x),0) - p(x,e(x))\tfrac{1}{r}\left(1-e^{-rL(x)}\right)u_{\Delta}(w(x))
\end{aligned}
$$

$$\text{Where } u_{\Delta}(w,H) = u(w,1) - u(w,H)$$

The first two terms here are the utility an individual of type x would attain if they were to survive for L(x) periods with income w(x). EU can be simplified to:

$$EU(w(x),H(x),L(x)) = U(w(x),1,L(x)) - p(x,e(x))\tfrac{1}{r}\left(1-e^{-rL(x)}\right)u_{\Delta}(w(x))$$

As in PZ's original model, expenditures are targeted towards specific types but are paid for by all individuals. The original model assumed that all individuals would make the same contribution towards health care. This poses severe equity questions for those who have a short life expectancy in the revised model. Likewise, per-period contributions have been rejected on the grounds that the number of periods in the model is arbitrary. This model instead assumes that individuals contribute a constant amount, $\bar{e}$, over the period of time they live for.[6] Total contributions are therefore given by:

$$\sum_x f(x)\tfrac{1}{r}(1-e^{-rL(x)})\bar{e}$$

Where all expenditures take place at time zero, total expenditures on illness prevention are given by:

$$\sum_x f(x)e(x)$$

The constant contribution made by each individual towards funding expenditures is then:

$$\bar{e} = \frac{\sum_x f(x)e(x)}{\sum_x \tfrac{1}{r} f(x)(1-e^{-rL(x)})}$$

This sum is paid continuously, leaving post-tax income of $w(x) - \bar{e}$ for an individual of type x. Incorporating payments towards health expenditures, EU becomes:

$$EU(w(x)-\bar{e},H(x),L(x)) = U(w(x)-\bar{e},1,L(x)) - p(x,e(x))\tfrac{1}{r}\left(1-e^{-rL(x)}\right)u_{\Delta}(w(x)-\bar{e})$$

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[6] This is equivalent to a per-period contribution where each period is of an infinitely small duration.

Behind a veil of ignorance, EU is calculated by taking the unweighted sum of the utilities and is represented by $\overline{EU}$.

$$\overline{EU} = \sum_x f(x)EU(w(x) - \bar{e}, H(x), L(x))$$
$$= \sum_x f(x)U(w(x) - \bar{e}, 1, L(x)) - \sum_x f(x)p(x, e(x)) \tfrac{1}{r}\left(1 - e^{-rL(x)}\right)u_\Delta(w(x) - \bar{e})$$

The first order conditions for EU maximisation are:

$$(\forall x) \quad 0 = -f(x)p_e(x, e(x)) \tfrac{1}{r}\left(1 - e^{-r\,L(x)}\right)u_\Delta(w(x) - \bar{e}, H(x)) + \frac{f(x)}{\sum_y \tfrac{1}{r} f(y)\left(1 - e^{-r\,L(y)}\right)} \tfrac{d}{d\bar{e}}\overline{EU}$$

Now $\tfrac{d}{d\bar{e}}\overline{EU}$ is the expected disutility from a unit increase in the contribution level. This can also be expressed using the societal (expected) marginal utility of income, as contributions are simply deducted from income. The first order conditions become:

$$(\forall x) \quad 0 = -f(x)p_e(x, e(x)) \tfrac{1}{r}\left(1 - e^{-r\,L(x)}\right)u_\Delta(w(x) - \bar{e}, H(x)) - \frac{f(x)}{\sum_y \tfrac{1}{r} f(y)\left(1 - e^{-r\,L(y)}\right)} \tfrac{d}{dw}\overline{EU}$$

And on rearranging the first order conditions:

$$(\forall x) \quad -\frac{1/p_e(x, e(x))}{\tfrac{1}{r}\left(1 - e^{-r\,L(x)}\right)} = u_\Delta(w(x) - \bar{e}, H(x)) \Big/ \frac{\tfrac{d}{dw}\overline{EU}}{\sum_y \tfrac{1}{r} f(y)\left(1 - e^{-r\,L(y)}\right)} \qquad (1)$$

In order to aid interpretation of these first order conditions, we divide each side by the health benefits of a successful cure, 1 - H(x).[7] The first order conditions become:

$$(\forall x) \quad -\frac{1/p_e(x, e(x))}{\tfrac{1}{r}\left(1 - e^{-r\,L(x)}\right)(1 - H(x))} = \frac{u_\Delta(w(x) - \bar{e}, H(x))}{(1 - H(x))} \Big/ \frac{\tfrac{d}{dw}\overline{EU}}{\sum_y \tfrac{1}{r} f(y)\left(1 - e^{-r\,L(y)}\right)} \qquad (2)$$

First, consider the left-hand side of equation (2). Since $p_e(x, e(x))$ is the decrease in the probability of illness from a unit increase in expenditure, the cost of abating a statistical illness is $-1/p_e(x, e(x))$. Individuals who benefit from improved health do so by an amount (1-H(x)) over their discounted life expectancy, $\frac{1}{r}\left(1 - e^{-r\,L(x)}\right)$. Therefore, the left-hand side of (2) represents the cost-per-QALY of improving expected health status. Now consider the right hand side of equation (2). The utility benefit per QALY is calculated as the utility value of an abated illness, $u_{\Delta}(w(x) - \bar{e}, H(x))$, divided by the health improvement this represents, (1-H(x)). The average (societal) marginal disutility of financing expenditure is calculated as the societal marginal utility of income divided by average discounted life expectancy. Therefore, the right hand side of (2) represents society's marginal WTP-per-QALY. EU maximisation then requires that society equalise the marginal cost and marginal WTP-per-QALY for each type.

The effect of including life expectancy

The first order conditions in equation (2) show that, in the absence of other differences between types, differences in life expectancy result (from behind the veil of ignorance) in those with longer life expectancies attracting greater expenditure to reduce their risk of illness. It seems intuitive that the longer an individual's life expectancy, the longer she will enjoy the benefit of successful abatement of illness, so the more she will contribute towards societal EU from behind the veil.

To see this, consider a society which is made up of equal numbers of two types, X and Y, who both face the risk of an illness that will reduce them to a state equivalent to death (i.e. H(X)=H(Y)=0). Both types have utility functions $u(w, H) = (1 + 4H)\ln(w)$ and initial income of 500. The probability of any individual falling ill is given by $0.001\ e^{-0.01\ e(i)}$, where e(i) is expenditure on individual i. Types X and Y have life expectancies of 20 years and 10 years, respectively (which correspond to 12.64 years and 7.87 years when discounted exponentially at 5%). A society that maximises EU from behind a veil of ignorance will choose to spend $114.98 on each type X and $67.58 on each type Y, and is willing to pay $315,765 to cure an individual of type X and $196,551 to cure an individual of type Y. This converts into $24,977 per discounted QALY. The ratio between the WTP for a cure of individuals of types X and Y

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[7] While H(x) = 1 for hypothetical individuals not at risk of illness, the solution of the first order condition in this case is trivial.

will remain the same even if the fraction of each type changes. And so whilst the WTP-per-QALY will change, it does not differ by type.

A second effect of life expectancy is related to the time over which repayments occur. The longer any type is expected to live, the more they will contribute overall but the less they will contribute per year. Assuming now that both types have life expectancies of 20 years, society will increase its expenditure to $135.46 on all individuals from behind the veil of ignorance. The increase in overall life expectancy causes the average marginal disutility of financing expenditure to fall. As a result, society's WTP-per-QALY increases to $30,653.

This analysis shows that when life expectancy is introduced into the model, the constant WTP-per-QALY assumption is still valid if QALYs are discounted at an exponential rate and if life expectancy is deterministic. In such circumstances, life expectancy does affect aggregate WTP but it does so in a way that retains a constant value per (discounted) life year. Given the complexity involved in introducing a stochastic element to life expectancy, such a refinement of the model has not been pursued in this paper. In principle, however, there is no reason why it could not be incorporated. We have decided instead to focus attention on the impact of differential health status, to which we now turn.

The effect of including health status

Health status enters equation (1) as the utility associated with an abated illness. This increases in income and decreases in health status, implying that society places a higher absolute value on curing the wealthy and those most at risk of serious illness. As health status was not part of their model, PZ did not consider the rate at which WTP increases with respect to H(x). But by assuming that QALYs are a valid cardinal utility function (in a world where income is constant), Johannesson (1995) has claimed that it is possible to make the link between CBA and CEA.

The restriction that QALYs form a valid cardinal utility function defines the way in which health enters the utility function. At any given level of income, the utility value of a given improvement in health status is the same, regardless of the initial health of the individual.

Since the utility value per QALY, $u_\Delta(w, H)/(1-H)$, must be constant for all values of H, this assumption implies that the value of a cure to a patient with illness H must satisfy:

$$(\forall H) \quad u_\Delta(w, H) = (1 - H)u_\Delta(w, 0) \tag{3}$$

Substituting (3) into (2), the first order condition for EU maximisation becomes:

$$-\frac{1/p_e(x, e(x))}{\frac{1}{r}\left(1 - e^{-r\,L(x)}\right)(1 - H(x))} = u_\Delta(w(x) - \bar{e}, 0) \Bigg/ \frac{\frac{d}{d\bar{e}}\,\overline{EU}}{\sum_y \frac{1}{r} f(y)\left(1 - e^{-r\,L(y)}\right)} \tag{4}$$

Therefore, societal WTP-per-QALY gained is constant with respect to health status. A representation of a value function for a cure that is consistent with this is shown in Figure 1. The assumption that income is constant across society is required here, as a cursory examination of the diagram reveals that the utility associated with abated illness is a function of income. Only in the special case where equation (3) holds will the utility function result in WTP that does not differ in income (even after the removal of differences in marginal utility from using a veil of ignorance).

For illustrative purposes, Figure 2 shows the value from abated illness in which the WTP-per-QALY assumption does not hold. At any positive level of income, the lines, although equidistant in health status, are no longer equidistant in value. The utility value of the first 10% of health status (the vertical difference between the $u_\Delta(w, 0)$ and $u_\Delta(w, 0.1)$ lines) is considerably greater than the utility value of the final 10% of health status (the vertical difference between the $u_\Delta(w, 0.9)$ and $u_\Delta(w, 1)$ lines).

Rather unsurprisingly, then, the 'QALY as a valid cardinal utility function' assumption is crucial here. There is - and no doubt will continue to be - considerable debate about its validity, both at the individual level and at the societal level where it will sometimes be necessary to incorporate any interdependence between utility functions into the societal utility function.[8] But even if we accept the assumption, JM's claim that PZ's model enables a link to be made between CBA and CEA rests on a special case of economic unreality where income is

[8] Although in the cases of safety-based and paternalistic altruism, these preferences may not affect societal WTP (see Jones-Lee 1992).

constant across society. So while PZ's model may represent the "strongest theoretical justification to date" for a link between the two forms of analyses, it remains a very tenuous one if incomes must held be constant to achieve it. In the following section, therefore, we look at the implications of relaxing the constant income assumption.

Abandoning the constant income assumption

In order to relax the assumption that income is constant across all individuals, it is required that the value of abated illness does not vary in income. For the QALY assumption to hold in a world with constant income, the identity $u_{\Delta}(w,H) = (1-H)u_{\Delta}(w,0)$ must hold for all values of health status. Where this condition is dropped and incomes are allowed to vary, the identity must now hold for all values of health and income so that:

$$(\forall w, H) \qquad u_{\Delta}(w,H) = (1-H)u_{\Delta}(0,0)$$

What, then, is the implication of this for the utility function? Figure 3 shows a utility function (which satisfies the assumption that QALYs are a valid cardinal measure of utility) in a world with constant income across all individuals. Here, at any specified level of income, the value an individual places on abating an illness is a function only of how extreme that illness is. Figure 4 shows a utility function that satisfies the QALY assumption in a world where income may vary across individuals. Here the value an individual places on an abated illness (in utility terms) is a function only of how extreme that illness is, and is not affected by wealth. As a result, cross-sections of the utility function through health appear simply as vertical translations of the same curve. Consider the value of an abated illness where that illness is equivalent in utility terms to death. Without loss of generality, we can write $u_{\Delta}(w,0) = 1$ and, the utility function can be written as:

$$u(w,H) = u(w,0) + H$$

The discounted utility function is then equal to:

$$U(w, H, L) = \tfrac{1}{r}\, u(w, 0) + \tfrac{1}{r}\left(1 - e^{-rL(x)}\right)H$$

So, if there is to be a direct link between CBA and CEA, not only must the number of QALYs, $\tfrac{1}{r}(1 - e^{-rL(x)})H$, appear in every individual's cardinal utility function but also the health component of that utility function must be additively separable from the income component.

So, in addition to the conditions required in PZ's model, two additional conditions must be satisfied. First, the value of an abated illness must be a function only of the size of the health improvement, and second, the ability of an individual to enjoy income cannot be affected by illness. The latter of these conditions is highly counter-intuitive and is not supported by empirical evidence (see Evans and Viscusi 1993 and Sloan *et al* 1998).

CONCLUSION

As CEA has increasingly been used to evaluate resource allocation decisions in health care, economists have become increasingly interested in the extent to which CEA can provide a legitimate alternative to CBA within a standard welfare economic framework. Pratt and Zeckhauser (1996) have developed a model in which "spending on risk reduction is what a rational, albeit uninsured, individual confronting lotteries on future risks to life and wealth would choose for himself". This appears to provide a theoretical basis for building a welfare economic bridge between the two forms of analyses (see Johannesson and Meltzer 1998).

If the link between CBA and CEA is to be of any practical relevance, it is necessary to incorporate both length of life and quality of life into Pratt and Zeckhauser's original model. It has been shown in this paper that the constant WTP-per-QALY assumption is still valid if: i) life expectancy is deterministic; ii) life years are discounted at an exponential rate; and iii) QALYs fully represent an individual's cardinal utility function. It ought to be possible to relax (i) and it might be possible to relax (ii) (but only by introducing dynamic inconsistency into the model). However, the third and final assumption is a particularly unrealistic one since it requires either that income is constant across society or that illness does not affect the ability of an individual to enjoy income.

In order to forge a link between CBA and CEA in a real-world setting we require assumptions that heavily restrict the interaction between preferences over health and non-health arguments in the utility function. In the absence of a bridge that is able to reconcile the central conflict between utility and health maximisation, the debate about the appropriateness of CBA vis-à-vis CEA must continue. It would appear 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. Rather, the debate should perhaps turn its attention to the relative merits of welfarist and non-welfarist philosophies in the context of allocation decisions in health care and other public services.

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Figure 1: Constant WTP per QALY at any given income level

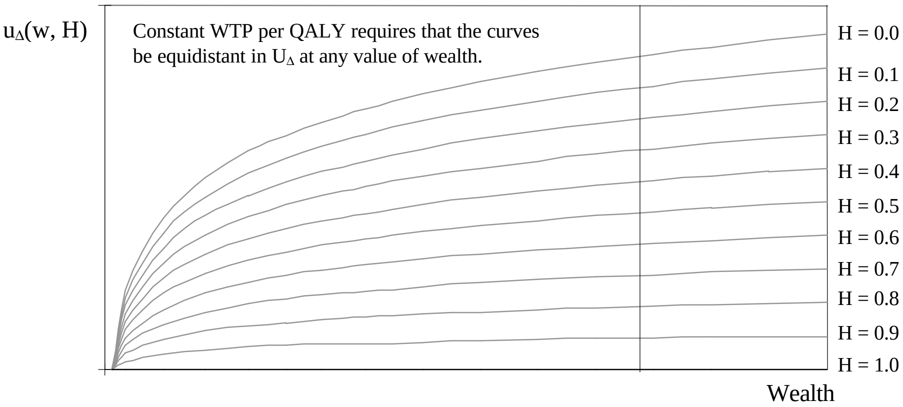

Figure 2: Variable WTP-per-QALY at any positive income level

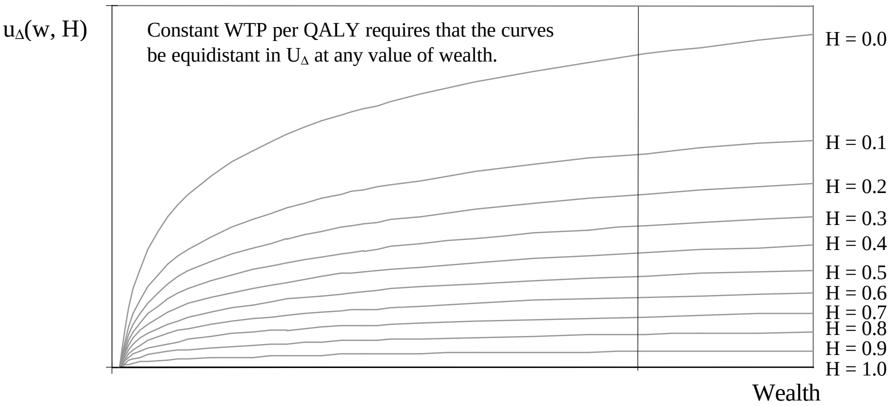

Figure 3: Constant WTP per QALY at any given income level

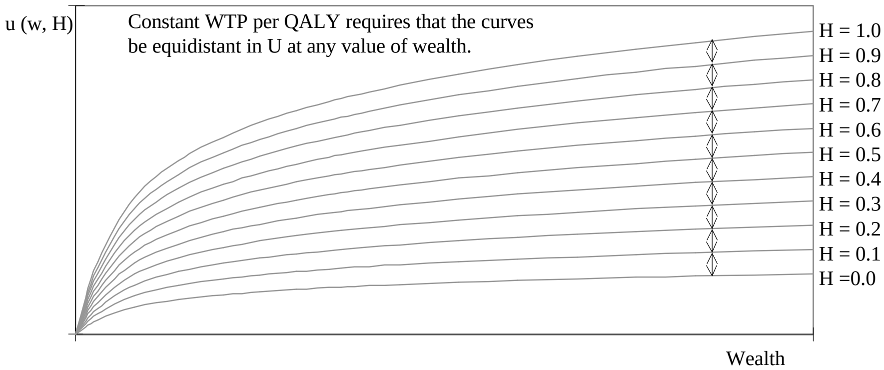

Figure 4: Constant WTP per QALY at all income levels.