Measuring the value of life: Exploring a new method for deriving the Monetary Value of a QALY

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Introduction

Economic evaluations of new health technologies now typically produce an incremental cost per Quality Adjusted Life Year (QALY) value. The challenge for decision making bodies, such as NICE in the U.K., is then to decide how much it is willing to recommend the NHS to pay for a gain of one QALY. One approach is to set a fixed cost-effectiveness threshold. For example, in the UK the threshold against which new treatments are compared is between £20,000 and £30,000 (NICE 2008). If the cost per QALY for a treatment falls below this threshold then it will receive funding. The drawback is that this threshold is set arbitrarily.

Recent research has sought to determine the monetary value individuals place on a QALY to inform the size of the healthcare budget and the level of the cost-effectiveness threshold. This research has predominantly used Willingness to Pay (WTP) approaches to estimate the monetary value of a QALY (Johannesson and Meltzer 1998, Hirth et al. 2000, Abelson 2003, Johannesson and Johansson 1997, Johnson et al. 1998, Gyrd-Hansen 2003). However, WTP has a number of known problems, most notably its insensitivity to scope. In this paper we present an alternative approach to estimating the monetary value of a QALY (MVQ), which is based upon a Time Trade Off (TTO) exercise of income with health held constant at perfect health. We present the methods and theory underlying this approach and some results from an online survey in the Netherlands.

Background

Willingness to Pay (WTP) has been used to estimate the monetary value of a QALY in two ways. The first has been to elicit the WTP for a reduction in the risk of death and then calculate the value of a statistical life, from which the MVQ can be inferred (e.g. Johannesson and Meltzer 1998, Hirth et al. 2000, Abelson 2003). These studies produce WTP per QALY estimates ranging from £51,000 to £101,000 (in 2003 prices). The second approach has been to directly elicit a WTP value for changes in health status (e.g. Johannesson and Johansson 1997, Johnson et al. 1998, Gyrd-Hansen 2003). Estimates from this approach are generally lower and range from £330 to £7,500 (also in 2003 prices).

WTP has a number of known problems. The questions presented to respondents can either be open-ended or closed-ended. Typically an open-ended question would ask respondents the maximum amount they would be prepared to pay for a given benefit such as an improvement in health. A closed-ended question would ask respondents if they would pay a specific amount for the benefit. While it is believed that open-ended questions produce unbiased estimates because the respondent is not prompted, responses can be very imprecise and plagued by non-responses or protest responses (Johannesson, 1996a). While closed-ended questions improve the precision of results, reference point bias may exist if respondents' WTP is affected by the first value that they are presented with. Evidence on starting point bias is inconclusive: Stalhammer (1996) found evidence, while O'Brien et al. (1998) specifically tested for it and found no evidence.

Perhaps the greatest weakness of WTP is its insensitivity to scope. Prades, Loomes and Brey (2008) attempted to estimate the MVQ by surveying 900 members of the Spanish population, through open-ended questions. They found WTP to be insensitive to both the size of the health gain and the duration of the period of payment. This suggests that respondents have a socially acceptable amount of money in mind, and this is the amount they will pay regardless of the size of the health gain they are presented with.

WTP is ultimately determined by ability to pay; in other words personal income acts as the budget constraint. O'Brien and Drummond (1994) argued that WTP was only a valid method if we accept that the current distribution of income is appropriate. WTP, other things equal, increases the likelihood that treatments aimed at the affluent would get funded in preference over those aimed at the poor. Therefore, some argue that basing public policy on WTP would be inequitable.

A further problem with WTP is the potential for strategic behaviour on the part of the respondents (Duffield and Patterson, 1991). Intelligent respondents may deduce that the larger the amount of money they state they are willing to pay the more likely the treatment being valued will be provided. If the respondent may need this treatment in the future he/she has a clear incentive to give a very high WTP.

Even if we overlook the above problems of the WTP technique, at a more conceptual level, a 'social WTP value' is necessary to aid policy makers set an appropriate cost effectiveness threshold. Whether social WTP can be calculated as the average of individual WTP is far from clear. Smith and Richardson (2005) point out that individual WTP is predicated on the notion that the payment made by each individual will reflect the benefit that they receive from the good or service paid for. However, under a national health scheme, the payment is largely unrelated to the benefits that the payee will obtain. The relevant WTP question becomes how much the individual is prepared to pay for another's health, with the caveat that they too can potentially benefit from the services that others receive. Therefore, it is entirely possible for an individual's personal WTP to diverge from their fair share of social WTP.

Attempting to attach a monetary value to a QALY has been termed as 'building a bridge between CBA and CEA' (Dolan and Edlin, 2002). This is because if a monetary value of a QALY is identified, then the costs of a treatment can be directly compared with the benefits, expressed in monetary net benefit terms and interpreted in standard welfare economic terms. However, Dolan and Edlin (2002) have shown that some rather restrictive and unrealistic assumptions have to be made to build this bridge. The approach of Johannesson and Meltzer (1998) requires that incomes be held constant across individuals for WTP to be proportional to the QALY gain. Dolan and Edlin relax this assumption and show that health must be additively separable to consumption in the utility function, since the relationship between health and income would influence the ability of an individual to enjoy consumption. Another attempt to link CBA and CEA, by Bleichrodt and Quiggin (1999), differs in that individual WTP figures are used, but this leads to differences in thresholds across individuals. Ultimately, Dolan and Edlin argue that it is not possible to link CBA and CEA if: (i) the axioms of EU theory hold; (ii) the QALY model is valid in a welfare economic sense; and (iii) illness hinders the ability to enjoy consumption.

In order to estimate an MVQ it is crucial to decide what to include in the QALY. The Washington Panel (Gold *et al.* 1996) controversially recommended that productivity costs should not be included in the numerator of a cost effectiveness analysis as a negative cost. Their reasoning behind this recommendation was the assumption that respondents in health state valuation exercises consider the effect a state will have upon their income, and income acts as a proxy for productivity costs. If this is the case, then the implication would be that the MVQ will be some composite of the pure monetary value of health, and the value of health on the individual's productivity and earning capacity. A number of studies have tested the Washington Panel's assumption (see Tilling et al. 2008 for a review). They generally find that the majority of respondents in health state valuation exercises do not spontaneously consider income effects, and for those that do their valuations do not change significantly. This suggests that the QALY does not include income, and the MVQ can be the monetary value of health alone.

The aim of this study is to offer an alternative approach to estimating a monetary value for a QALY by identifying the level at which individuals trade off between their own longevity and income. This approach may overcome some of the problems with WTP, such as insensitivity to scope, strategic behaviour and dependence upon ability to pay. Below, the study design, results, and a discussion are presented.

Methods

Data were gathered as part of a study seeking to determine whether respondents in TTO exercises consider the effects the states might have upon their income. Data were gathered through an online self-complete questionnaire administered in the

Netherlands. Invitations were sent out to a subset of an existing panel of potential survey respondents in order to obtain a representative sample of 300 members of the Dutch general public. We selected respondents between the ages of 18 and 65 as we felt that questions about income were most relevant for people in this age bracket. The data collection was performed by an online market research company (Survey Sampling International; www.surveysampling.com). Following a number of background, ranking and VAS questions respondents were presented with five different TTO exercises (see Tilling et al. 2009 for more details).

Two of these TTO exercises were relevant for this study and all respondents answered both:

*TTO 1: Trading years to avoid an income loss in perfect health (**equivalent loss**)*
"You can live for 10 years in perfect health with (100% - Y%) of your current income or a shorter period of time in perfect health with your current income."

*TTO 2: Trading years to achieve an income gain in perfect health (**compensating gain**)*
"You can live for 10 years in perfect health with your current income or a shorter period of time in perfect health with (100% + Y%) of your current income."

Three income change levels (Y%) were used: 20%, 40% and 60%, and respondents were randomised to one of these three income change levels which they then received in both TTO1 and TTO2.

Essentially both questions can be interpreted as WTP questions. However, while standard WTP questions ask people to trade *money* for an improvement in survival prospects, and thus by implication, length of life or health, these questions ask people to trade *length of life* for an improvement in income. Respondents are paying in years of life. TTO 1 is a form of equivalent variation. Equivalent variation is 'the amount of money a consumer would pay to avert a price increase' (Hicks 1939). In TTO1 the consumer is faced with a fall in income, which is essentially the same as an increase in prices. They are then asked how many years of life (rather than how much money) they would pay to avoid this 'price increase'. Similarly, TTO2 can be considered a form of compensating variation. Compensating variation is 'the amount of additional money a consumer requires to reach his initial level of utility after a change in prices' (Hicks 1939). For a drop in prices, the amount of additional money compensation will be negative. TTO2 essentially corresponds to a compensating variation that identifies the number of years payable that would let the individual maintain the initial level of utility after a drop in prices, or increase in income.

The results from these questions, with some assumptions, allow us to calculate the change in quality of life caused by a change in income. The point of indifference in TTO1 gives us the following information:

$$10 * U\ (\text{Perfect Health, Low Income}) = X * U\ (\text{Perfect Health, Normal Income}) \quad (1)$$

If we set 'U (Perfect Health, Normal Income)' equal to 1, which is a standard QALY assumption, we can simplify as follows:

$$10 * U\ (\text{Perfect Health, Income Low}) = X \quad (2)$$

$$U\ (\text{Perfect Health, Income Low}) = X/10 \quad (3)$$

We label this an expanded QALY (eQALY) as it includes both health and income. One eQALY represents 1 year of U (PH, NI), where PH is perfect health and NI is normal income. Note that 1 is only the normalisation point, not the upper bound as in the conventional QALY, because if income exceeds normal income (as in TTO2) the value can exceed 1. Therefore, X/10 represents the eQALY weight with reduced income. This requires that we assume additivity between health and income in the utility function. In reality it is likely that the utility from a year in perfect health will be higher when combined with a higher amount of income. Therefore, we make the same assumption as Johannesson and Meltzer (1998), which means that we have not avoided Dolan and Edlin's (2002) impossibility theorem. We also assume a constant marginal rate of substitution between health and income. Relaxing this assumption would require us to estimate an indifference curve across a range of values. Unfortunately we do not have enough data points for this to be possible in this study.

The most appropriate way to derive MVQ estimates depends on what we wish to include in the QALY. We have information on individual income. Imagine that an individual states that 9 years with normal annual income of €100,000 is equivalent to 10 years with 80% of this income, so €80,000. Therefore, equation (1) would become:

10 * U (Perfect Health, €80,000) = 9 * U (Perfect Health, €100,000) (4)

Normalising U (PH, €100,000) to 1 gives us:

10 * U (Perfect Health, €80,000) = 9 (5)

U (Perfect Health, €80,000) = 0.9 (6)

We can see that a fall in annual income of €20,000 has caused a fall in utility of 0.1. Therefore we can estimate an MVQ value for this individual as follows:

€20,000/0.1 = **€200,000**

Note that so far we have dealt exclusively with annual income. Given that we assume additivity between health and income we could think in terms of lifetime income. Considering the same individual, we could then calculate an MVQ estimate as follows:

10U (Perfect Health) + €800,000 = 9U (Perfect Health) + €900,000 (7)

10U (Perfect Health) – 9U (Perfect health) = €900,000 - €800,000 (8)

U (Perfect Health) = **€100,000** (9)

It is clear that this estimate is considerably lower than the previous one. In fact, the difference between the two estimates is equal to the individual's annual income. The first method, the 'annual approach', estimates the monetary value of an eQALY, U(PH, NI). The second method, the 'lifetime approach', estimates a monetary value a conventional QALY, U (PH). Based on the arguments set out in the previous section, we use the latter 'lifetime approach' to generate estimates of U (PH) only.

The compensating gain data from TTO2 is analysed in a similar fashion to the equivalent loss data in TTO1. Consider the eQALY calculation applied to a hypothetical compensating gain individual who is indifferent between 10 years with their current income and 9 years with 120% of their current income. Their income is, once again, €100,000 per year:

10* U(PH, €100,000) = 9* U(PH, €120,000) (10)

Normalise so that U(PH, €100,000) = 1

U(PH, €120,000) = 10/9 (11)

We can see that an increase in annual income of €20,000 has caused an increase in utility of 0.111[•]. Therefore we can estimate the monetary value of an eQALY as follows:

€20,000 / 0.111 = **€180,018**

Notice that a compensating gain of €20,000 has led to a lower monetary estimate of an eQALY than a gain of €20,000 in the equivalent loss question. This is because, as a proportion, €20,000 is larger in the equivalent loss question. Now consider the conventional QALY calculation for the same individual:

10 U(PH) + €1000,000 = 9 U(PH) + €1080,000 (12)

10U (PH) – 9U (PH) = €1080,000 – €1000,000 (13)

U(PH) = **€80,000** (14)

Once again, the estimate is lower than in the equivalent loss question. Also, note that there is a slight discrepancy in the relationship between the eQALY and the conventional QALY. The eQALY is €18 greater than the conventional QALY plus annual income. This is because the eQALY improvement is 0.111 rather than 0.1. The larger the number of years traded in the compensating gain question the larger the discrepancy in the relationship between the eQALY and the QALY. For example, if 2 years are traded the eQALY improvement would be 0.25 rather than 0.2. For the reasons already outlined, we calculate monetary estimates of only the conventional QALY.

Predicting which of the two questions will give the higher estimates is not obvious. As shown above, if an individual trades the same number of years in each question the compensating gain question will give lower results. However, based on the assumption of diminishing marginal utility of income we would expect the compensating gain results to give a higher MVQ than the equivalent loss. Respondents will trade fewer years in order to achieve an increase in income, hence each year is valued more highly in monetary terms. This is also supported by the findings of Kahneman and Tversky (1979): through a series of probabilistic choices they found risk aversion in choices involving sure gains, and risk seeking involving sure losses. This suggests that respondents will trade more years in the equivalent loss questions than in the compensating gain questions, which would lead to higher MVQ values in the latter.

In the background characteristics respondents chose the income bracket within which their monthly income fell. For our analysis these income brackets were converted into numerical values using the mid-point of each bracket (Layard et al. 2008). For respondents in the lowest income bracket an income of two thirds of the upper limit of the bracket was used. For respondents in the highest income bracket an income of 1.5 of the lower income limit of the bracket was assumed (Layard et al. 2008).

Given that the 3 TTO exercises that are not analysed in this paper involved 4 states each, there were a total of 14 TTO questions per respondent. Some respondents did not trade any time in any of the TTO exercises. We have excluded these ‘extreme’ non-traders from our analysis. However, some respondents may have traded in some of the TTO’s but not in the compensating gain and equivalent loss questions. If we calculate an MVQ for each individual and then aggregate (as outlined above), then these non-traders cause a problem because the left hand side of equation (8) becomes 0, meaning that the equation would give an indeterminate value. There are two possible responses to this problem: the first is to exclude all respondents that did not trade, and the second is to aggregate at the start of the calculations i.e. use aggregate income and aggregate number of years traded. We present results from both approaches.

One further problem is the generation of negative MVQ values. For TTO1 if the percentage of life years the respondent is prepared to give up is larger than the percentage income loss he is faced with then his MVQ will be negative. In other words if the respondent is faced with 20% income loss, if they trade more than 2 years their MVQ value will be negative. If they trade exactly 2 years their MVQ value will be zero. So for the 40% loss they can not trade more than 4 years, and for the 60% loss they can not trade more than 6 years. For TTO2 the relationship is not linear. For 20% gain they can not trade more than 1.666 years, for 40% gain they can not trade more than 2.86 years and for 60% gain they can not trade more than 3.75 years. In the individual approach we truncate negative MVQ values at 0. In the aggregate approach we leave the aggregate number of years traded unchanged.

Probit regressions were used to assess the affect of background characteristics on the likelihood of respondents either not trading, or trading so much that they generated negative MVQ values. However, there was very little significance in these models. Therefore, we do not present the results from these models.

Results

Data are available from 321 members of the Dutch general public. After exclusion of 80 ‘extreme non-traders’ the sample size falls to 241. Analysis performed in Tilling et al. (2009) shows that only 2 background variables were significantly correlated with being an extreme non-trader at the 1% level: respondents with children were more likely not to trade in any of the exercises, as were those who spontaneously included income in the standard TTO question of hypothetical health states. Extreme non-traders were in better health than traders, though this was only significant at the 10% level.

Table 1 shows the background characteristics for the full sample (excluding extreme non-traders) and then for each version (income change level) of the questionnaire. The sample has slightly more males than females. 41.5% of the sample are not employed. Just under half of the sample had children. Less than half of the sample are married and the mean VAS score for own health was 0.75. The results of the Chi^2 tests show that the background characteristics do not differ significantly across the three versions of the questionnaire. Only employment is weakly significantly different across the versions, with a smaller proportion of respondents in version 2 being in employment than in the other 2 versions.

Table 1 – Background characteristics by income change level

		Full Sample	Version 1 (20% income change)	Version 2 (40% income change)	Version 3 (60% income change)	Chi² Test (p-values)
Number of Respondents		241	78	80	83	
Gender	Male	52.0%	50.0%	56.0%	49.5%	0.683
	Famale	48.0%	50.0%	44.0%	50.5%	
Age	Average (SD)	43.19 (13.19)	43.71 (12.96)	42.91 (13.20)	42.96 (13.52)	0.808
	18-35	32.0%	32.0%	31.0%	32.5%	
	36-50	31.5%	32.0%	28.0%	35.0%	
	51-65	36.5%	36.0%	41.0%	32.5%	
Educated beyond the minimum school leaving age	Yes	66.0%	69.0%	64.0%	65.0%	0.750
	No	34.0%	31.0%	36.0%	35.0%	
Educated to Degree Level	Yes	32.0%	37.0%	30.0%	29.0%	0.479
	No	68.0%	63.0%	70.0%	71.0%	
Employment	Employed	53.5%	58.0%	45.0%	58.0%	0.098
	Self-Employed	5.0%	4.0%	10.0%	1.0%	
	House Wife/Husband	12.5%	10.0%	17.5%	9.5%	
	Pensioner	7.0%	9.0%	4.0%	8.5%	
	Work Seeking	3.0%	5.0%	1.5%	2.5%	
	Unable to Work	10.0%	10.0%	11.0%	8.5%	
	Student	9.0%	4.0%	11.0%	12.0%	
Net Own Monthly Income	<1000 Euros	38.0%	37.0%	46.0%	31.5%	0.237
	1000 - 1499	21.5%	18.0%	20.0%	26.5%	
	1500 - 1999	19.0%	20.5%	20.0%	15.5%	
	>2000 Euros	21.5%	24.5%	14.0%	26.5%	
Children	Yes	49.5%	49.0%	52.5%	47.0%	0.773
	No	50.5%	51.0%	47.5%	53.0%	
Religion	Protestant	16.5%	14.0%	16.5%	19.0%	0.461
	Roman Catholic	28.5%	33.5%	27.5%	25.5%	
	Atheist	49.5%	43.5%	51.0%	2.5%	
	Other	5.5%	9.0%	5.0%	53.0%	
Marital Status	Married	42.5%	41.0%	47.5%	40.0%	0.561
	Single/Never Married	22.5%	19.0%	19.0%	29.0%	
	Divorced	12.0%	10.5%	16.0%	9.5%	
	Widowed	2.0%	2.5%	25.0%	1.0%	
	Living Together	18.0%	24.5%	12.5%	17.0%	
	Other	3.0%	2.5%	2.5%	3.5%	
Mean Self-Reported Health on the EQ-VAS[1]		0.75	0.73	0.73	0.77	0.131

[1] Due to the exclusion of some meaningless valuations, typically due to dead receiving a very high position on the VAS, the relevant sample sizes for this variable are: Full sample (213), Version1 (69), Version2 (69), Version3 (75).

Table 2 – Number of years traded both including and excluding non-traders

		20% (n=78)		**40% (n=80)**		**60% (n=83)**	
		Loss	**Gain**	**Loss**	**Gain**	**Loss**	**Gain**
Number of years traded to either avoid an income loss or achieve an income gain including non-traders	Mean	0.99[2]	1.47	1.81[2]**	1.33	2.45[1]	1.51[1]***
	SD	2.23	2.96	2.74	2.63	3.28	2.89
	Median	0	0	0	0	1	0
	75th Percentile	0.25	1.42	4	1.08	4.5	1.75
	90th Percentile	4.92	5	5	5.5	8.92	5
		Loss (n=22)	**Gain (n=29)**	**Loss (n=37)**	**Gain (n=28)**	**Loss (n=46)**	**Gain (n=30)**
Number of years traded to either avoid an income loss or achieve an income gain excluding non-traders	Mean	3.5	3.95	3.91	3.81	4.43	4.17
	SD	2.99	3.74	2.83	3.24	3.27	3.47
	Median	2.25	2.5	4	2.96	3.75	2.75
	75th Percentile	5	5	5	6	6.42	7
	90th Percentile	9	10	9	10	9.92	9.96

Table 2 shows the mean number of years respondents were willing to trade, in both the compensating gain and equivalent loss questions, with and without respondents who did not trade any time. Looking at the values for the larger sample, for two of the income change levels respondents are prepared to trade more years to avoid an income loss than they are to achieve an income gain. However, these differences are only significant for the 60% income change level (tested through t-test and signalled by 1***, the number indicating the points of comparison and the *'s indicating the level of significance: * 10%, **5%, ***1%). The median values are 0 in all but one case, which is a product of the large numbers of non-traders. Mann-Whitney rank-sum tests were performed comparing the values for the different income levels, both for income loss and income gain values. Comparison between 20% and 40% income loss proved significant at the 10% level, while comparison between 20% and 60% income loss proved significant at the 1% level. For the equivalent loss questions the standard deviations generally increase as the level of loss increases, while no clear relationship can be observed for the gain questions. The 75th and 90th percentiles show the skewness caused by the non-traders.

For the smaller sample, excluding non-traders, the mean number of years traded is considerably higher across all questions. More years are traded in the equivalent loss questions for the two more severe income change levels, but these differences are not significant. None of the t-tests comparing values across the different income levels for both losses and gains are significant.

Table 3 shows the MVQ estimates calculated at the individual level, excluding non-traders. The mean MVQ values range from €480.89 to €4,204.00. A larger proportion of respondents gave negative MVQ values (which were truncated to zero) for the compensating gain questions than for the equivalent loss questions. In these questions fewer years have to be traded to generate negative values. In general the mean MVQ values increase as the level of income change increases and the values are higher for the gain questions than the loss questions, except in the case of the largest income change level. The mean values are consistently higher than the median values which shows that the data are skewed. In half of the cases the median is 0 which is caused by the large number of respondents who traded enough years to generate a negative MVQ value, which was then truncated to zero.

Table 3 – MVQ values calculated at the individual level (excluding non-traders)

		20%		40%		60%	
		Loss	**Gain**	**Loss**	**Gain**	**Loss**	**Gain**
		(n=22)	(n=29)	(n=37)	(n=28)	(n=46)	(n=30)
Mean number of years traded		3.5	3.95	3.91	3.81	4.43	4.17
Mean Annual Income (Euros)		15,041.50	16,375.45	14,833.95	15,675.43	21,041.22	18630.4
Number of negative responses (truncated to zero)		11	17	16	14	13	14
Income equivalent to 1 Quality Adjusted Life Year (Euros)	Mean	**480.89**	**605.65**	**1504.89**	**1672.75**	**4204.00**	**3677.18**
	SD	806.52	1424.41	2322.32	2199.91	4816.42	5113.11
	10th percentile	0.00	0.00	0.00	0.00	0.00	0.00
	25th percentile	0.00	0.00	0.00	0.00	0.00	0.00
	Median	0.00	0.00	0.00	246.42	3196.80	2397.60

Table 4 – MVQ values calculated at the aggregate level with and without non-traders

	20%		40%		60%	
Excluding non-traders	**Loss**	**Gain**	**Loss**	**Gain**	**Loss**	**Gain**
Number of Respondents	22	29	37	28	46	30
Mean number of years traded	3.5	3.95	3.91	3.81	4.43	4.17
Mean Annual Income (Euros)	15,041.50	16,375.45	14,833.95	15,675.43	21,041.22	18630.4
Value of a QALY (Euros)	**-22562.25**	**-4486.87**	**1335.06**	**-2091.10**	**33034.72**	**-1251.96**
Including non-traders	**Loss**	**Gain**	**Loss**	**Gain**	**Loss**	**Gain**
Number of respondents	78	78	80	80	83	83
Mean number of years traded	0.99	1.47	1.81	1.33	2.45	1.51
Mean Annual Income (Euros)	17471.38	17471.38	15771.30	15771.30	20828.82	20828.82
Value of a QALY (Euros)	**17646.09**	**412.32**	**34539.15**	**3371.90**	**73942.31**	**7465.05**

Table 4 shows the MVQ values calculated using aggregate values, first for only the traders and then with the non-traders. In all but two cases using the aggregate approach with only the traders produces negative MVQ values. In the two cases where positive values are produced comparison with the results from the individual approach shows that the value for 40% loss is very similar. In the case of 60% loss the value generated from the aggregate approach is considerably higher than the one generated from the individual approach. Considering the results from the aggregate approach, including non-traders, the estimates range from €412.32 to €73,942.31.

Table 5 shows weighted mean QALY values for different income brackets for both the individual approach and the aggregate approach. There are two negative values for the aggregate approach that are, once again, truncated to zero for the calculation of the weighted mean. Both approaches show that the MVQ estimates consistently increase as respondent income increases. As in table 4 the estimates from the aggregate approach are considerably higher than those from the individual approach.

Table 5 – Weighted mean QALY values for different income brackets for both the individual approach and the aggregate approach

		20%				40%				60%				
	Income Level	**Loss**	**n**	**Gain**	**n**	**Loss**	**n**	**Gain**	**n**	**Loss**	**n**	**Gain**	**n**	**Weighted Mean QALY value**
Individual Approach														
	Less than 12,000 euros	339.05	11	433.85	14	1,054.50	18	1,040.17	11	2,510.31	13	1,617.78	11	**1,162.26**
	12,000 to 17,999 euros	750.00	5	637.50	4	1,375.00	7	2,378.57	7	3,204.55	11	4,050.00	4	**2,211.19**
	18,000 to 23,999 euros	0.00	2	0.00	5	2,775.00	7	2,305.00	7	5,463.89	9	5,600.00	5	**3,221.00**
	>24,000 euros	775.00	4	1,490.00	6	1,530.00	5	870.00	3	5,871.15	13	4,832.00	10	**3,584.02**
			22		**29**		**37**		**28**		**46**		**30**	
Aggregate Approach														
	Less than 12,000 euros	6569.42	29	-57.86	29	15392.59	37	1926.87	37	34093.87	26	2418.06	26	**9,677.41**
	12,000 to 17,999 euros	15000.00	14	1725.60	14	36645.00	16	3440.10	16	53700.00	22	7418.40	22	**21,347.35**
	18,000 to 23,999 euros	27552.00	16	-368.76	16	55461.00	16	3069.78	16	65415.00	13	8571.36	13	**25,990.52**
	>24,000 euros	32767.00	19	1207.76	19	64356.00	11	6020.20	11	90520.00	22	8079.84	22	**34,508.22**
			78		**78**		**80**		**80**		**83**		**83**	

Discussion and Conclusion

The aim of this study was not to present a definitive monetary value of a QALY for the Netherlands, but to test the feasibility of an alternative method of eliciting the monetary value of a QALY. This small-scale online study does suggest that compensating gain and equivalent loss TTO exercises are feasible alternatives that may overcome some of the problems inherent in WTP. This alternative method entails a greater sense of trade-off than WTP, since respondents are forced to consider giving up years of life from a finite 10 year survival, rather stating an open ended amount of money they would pay for a benefit they potentially can not relate to. The method makes strategic behaviour difficult as it is not obvious to the respondent how the results from the exercise will be used. The method also bounds the range of values it produces in contrast to the unbounded nature of WTP. While WTP is often found to be insensitive to scope our results show that respondents faced with a larger income change level were, on average, prepared to trade more years than those faced with a smaller income change level. The results show that the equivalent loss responses were more sensitive to scope than the compensating gain questions. WTP is criticised for its dependence upon respondents' ability to pay, but in practice there is nothing to stop respondents stating a WTP in excess of their financial means. While the values obtained from our method are also dependent upon respondent income, income acts as a constraint and providing that the sample has representative income levels our method may produce more meaningful results.

WTP exercises often ask respondents to value specific health improvements or treatments. In these circumstances the rich will be able to state greater WTP values for treatments they think will benefit them. While richer respondents will generate higher MVQ values in our method, since they are not valuing specific treatments but generic years of life there is little chance that decisions based upon the results will favour treatments aimed at the rich. Indeed, if our method is applied to a representative sample, the results can then be applied equally to any treatment.

Our method has two main problems. In this online study the greatest of these was the high propensity of non-responses. We feel that this is an artefact of using an online survey, rather than a protest against these particular questions. Van Nooten et al. (in press) also found numerous respondents opted not to trade in the TTO exercises in their online questionnaire. This argument is supported by the fact that in the whole study (Tilling et al. 2009) 80 of 321 respondents did not trade in any of the 14 TTO exercises. We suspect many of these respondents chose not to trade for strategic purposes. They may have deduced that the quickest way to complete the exercise is by choosing not to trade throughout. The sooner they complete the exercise the sooner they are awarded a given amount of money to be donated to a charity of their choice and the chance to win a prize themselves. Therefore, if this approach is to be tested further, it would be most appropriate to use an interview method of elicitation.

The second main problem is the elicitation of negative MVQ values. Referring to equation 7, given the assumption of additivity, a rational respondent should not trade more than 2 years (i.e. a value of 8 on the right hand side of the equation) because to do so would mean a lower total lifetime income. However, in reality it is plausible that individuals may wish to live for a shorter period of time with high income than for a longer period of time with lower income, even though their total lifetime income may be lower. It is also likely that respondents may not have been able to determine the point at which their lifetime income became lower. If these questions were tested through an interview elicitation procedure it may be possible to use a visual aid that would attempt to make it clearer to respondents the point at which lifetime income in the trading scenario becomes lower than lifetime income in the alternative scenario. This could be done by adapting the standard MVH TTO board to include an additional strip for lifetime income. This may reduce the number of respondents trading too many years.

In this study respondents were told to imagine perfect health in both scenarios, in future work it may be preferable to tell respondents they would be in their own current state of health. Their current health could then be valued through either TTO or VAS and the values obtained could be divided by the value of their current health to give MVQ values. This may reduce the number of hypothetical aspects and hence make the task more manageable for respondents who are currently not in full health. However, this approach would entail further dependence upon the assumption of no interactions between health and income. This assumption, one of the impossibility theorem criteria set out by Dolan and Edlin (2002) is not avoided in this study. The MVQ value elicited is essentially determined by the choice of income change level.

A large scale study would make it possible to gain values for enough income change levels to estimate an indifference curve between health and income. An average MVQ value across a range of income change levels could then be estimated.

It is not clear whether the ‘individual’ approach or the ‘aggregate’ approach is preferable. The income loss estimates are much higher when generated through the individual approach. This is to be expected given that the non-traders reduce the mean number of years traded, increasing the value of each year.   The compensating gain values are far more similar for the aggregate and individual approaches. The aggregate values show the same pattern as the individual values: as the income change level increases the MVQ estimate increases. The use of the aggregate approach with only traders does not appear to be a credible option due to the generation of negative values. The validity of results using the aggregate approach with non-traders is questionable as these valuations may be meaningless strategic non-trades. The individual approach has the drawback of small sample sizes. Comparison of the individual results and the aggregate results with non-traders show that the aggregate results are generally much higher and far more variable. Regardless of which method is used if the results are to be generalised to infer an MVQ it is crucial that the income of the sample is representative of society. Even if this method can be refined to estimate a reliable MVQ this does not overcome the problems of inferring a social value of a QALY from this information.

Probit regressions were used to assess the affect of background characteristics on the likelihood of respondents either not trading, or trading so much that they generated negative MVQ values. However, there was very little significance in these models, so we did not present the results. They did tentatively suggest (significant only at the 10% level) for two of the three income loss levels that someone with a degree is less likely to give a negative MVQ value. This perhaps suggests that more intelligent/educated respondents are better able to determine the point at which lifetime income in the trading scenario becomes less than lifetime income in the alternative scenario. They also suggest that for 40% compensating gain and 40% equivalent loss someone in work is more likely to not trade any years.

Finally, application of this method has highlighted the need to determine exactly what we wish to include in the QALY. This has implications not only for the reliable estimation of an MVQ but also for other aspects of economic evaluation such as the incorporation of productivity costs. Our estimates would have been considerably higher had we deemed income relevant in the QALY.

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