CHE

Centre For Health Economics

UNIVERSITY *of York*

Years of Good Life Based on Income and Health: Re-Engineering Cost-Benefit Analysis to Examine Policy Impacts on Wellbeing and Distributive Justice

Richard Cookson, Owen Cotton-Barrett, Matthew Adler, Miqdad Asaria, Toby Ord

CHE Research Paper 132

Years of good life based on income and health:
Re-engineering cost-benefit analysis to examine policy impacts on wellbeing and distributive justice

[1]Richard Cookson
[2]Owen Cotton-Barrett
[3]Matthew Adler
[1]Miqdad Asaria
[3]Toby Ord

[1]Centre for Health Economics, University of York, York, UK
[2]University of Oxford, Oxford, UK
[3]Duke University, North Carolina, USA

July 2016

Background to series

CHE Discussion Papers (DPs) began publication in 1983 as a means of making current research material more widely available to health economists and other potential users. So as to speed up the dissemination process, papers were originally published by CHE and distributed by post to a worldwide readership.

The CHE Research Paper series takes over that function and provides access to current research output via web-based publication, although hard copy will continue to be available (but subject to charge).

> *"the UK governmental body NICE (the National Institute for Health and Care Excellence)... has performed a signal service. It has shown to the world that the wellbeing approach can become an acceptable basis for public policy."*
>
> Lord O'Donnell, head of the UK civil service, 2005-2011
>
> (O'Donnell et al., 2014)

Introduction

In this paper, we propose a practical measure of individual wellbeing to facilitate the economic evaluation of public policies. We propose to evaluate policies in terms of years of good life gained, in a way that complements and generalises conventional cost-benefit analysis in terms of money. We aim to show how years of good life could be measured in practice by harnessing readily available data on three important elements of individual wellbeing: income, health-related quality of life, and longevity. We also aim to identify the main ethical assumptions needed to use this measure.

Our proposed measure is a straightforward extension of the 'quality adjusted life year' (QALY) measure of individual health used in health economics (Cookson and Culyer, 2010). Instead of measuring years of healthy life – the health QALY – we propose to measure years of good life – the wellbeing QALY.[1] The basic idea is the same: to measure years of life, adjusted for quality of life. The difference is just that we propose adjusting for aspects of quality of life related not only to health but also to income and the consumption of goods and services. We use a broad definition of 'income' that includes not only all sources of financial income after taxes – for example, from employment, financial assets and cash benefits – but also the imputed financial value of nonmarket goods and services provided or subsidised by the state – such as health, education and local public amenities – and by the family and others – such as housing, cooking and informal care.[2]

The wellbeing QALY is a practical tool that can be implemented in different ways and does not commit the user to any particular philosophical theory about the nature of individual wellbeing. For example, the wellbeing QALY could be interpreted either as an indicator of realised wellbeing or as an indicator of opportunity to realise wellbeing, insofar as income, health and longevity are all central ingredients both in people's actual achieved level of flourishing and also in their ability to achieve different levels of flourishing.[3] In other words, the wellbeing QALY indicates rather than constitutes wellbeing.

The most obvious application of our approach is to public health policies which are explicitly and primarily designed to impact on people's income, health and longevity, such as sales taxes on tobacco, alcohol and sugar. Such policies can be evaluated by combining epidemiological models of morbidity and mortality over the life course with economic models of supply and demand for the product under consideration. Models of this kind have been used by the UK government to evaluate alcohol minimum pricing proposals in England, allowing for differential impacts by age, gender, alcohol risk group and income group (Meier et al., 2016, Holmes et al., 2014). Once a combined

---

[1] Some authors refer to this concept as the 'wellbeing adjusted life year' (WELBY). We have no strong views on terminology, other than seeking to avoid an acronym with off-putting connotations such as WALY.

[2] Economists generally define an individual's 'consumption' as the market value of the goods and services they use in a given time period. This can differ from 'income', since income can be saved or given away rather than consumed, and consumption can be financed by borrowing or reducing one's stock of wealth. We do not have a strong view on whether to focus in practice on income or consumption, for two reasons. First, in practice income is often used as a proxy for consumption. Second, income and wealth can enhance wellbeing by providing financial security, even if it is not actually used to pay for goods and services – indeed, arguably, financial security can be thought of as a form of beneficial consumption.

[3] It can also be seen as a way of operationalising Amartya Sen's 'capability approach' in the context of economic evaluation – although this interpretation is controversial as different scholars interpret the capability approach in different ways. COOKSON, R. 2005. QALYs and the capability approach. *Health Economics,* 14**,** 817-829.

epidemiological-economic model of this kind has been built, it is then a fairly straightforward matter to take the outputs – income, health and longevity impacts by social subgroups – and convert them into wellbeing QALYs.

Our approach can also be applied to public policies which are not primarily designed to impact upon people's income, health and longevity – including policies on social care, education, transport, social protection and so on. These policies are currently evaluated using conventional cost-benefit analysis, based on a diverse range of policy outcome metrics converted into monetary values, usually without any underpinning economic-epidemiological model of impacts on income, health and longevity. Our approach can be used to complement conventional cost-benefit analysis by translating monetary benefits into years of good life gained. Any measure of policy outcome can be given a monetary value based on people's willingness to pay for improved outcomes. Our proposal is then to convert those monetary benefits into years of good life gained, using data on the individual's existing level of income and health and explicit normative assumptions about the rate of conversion from additional income into additional wellbeing.

Of course, wider public policies often do have important impacts on people's income, health and longevity, even if those impacts are not the primary policy objectives. For example, improvements in a child's educational outcomes and family stability can have important long-term impacts on their life chances – including their earnings, health and mortality risk later in life. So ideally our approach would be applied to wider public policies in two stages. First, the construction of a lifecourse economic-epidemiological model to estimate lifetime impacts on income, health and mortality. Second, the incorporation of wider outcomes relating to wider dimensions of wellbeing by converting them into consumption equivalent values. The 'full' income benefits – including the monetary value of wider outcomes – can then be combined with the health and longevity benefits to estimate years of good life gained.

An alternative way of implementing the concept of years of good life gained was recently proposed by the 'Commission on Wellbeing and Policy', chaired by a former head of the UK civil service, Lord O'Donnell (O'Donnell et al., 2014). O'Donnell and colleagues propose to adjust for quality of life directly using data on subjective wellbeing or life satisfaction, whereas we propose to adjust for quality of life indirectly using more readily available and arguably more informative data on income and (multiple dimensions of) health quality. The other leading alternative to conventional cost-benefit analysis is the 'equivalent income' approach (Fleurbaey and Schokkaert, 2013, Fleurbaey et al., 2013), which we return to in the discussion section.

What is wrong with conventional cost-benefit analysis?

In conventional cost-benefit analysis, non-monetary outcomes are given a monetary value based on how much people are willing to pay for them. These monetary amounts are then simply added up. Various methods have been proposed for adjusting or 'distributionally weighting' the monetary benefits before adding them up, but these are rarely used in practice. This conventional approach, which we shall refer to as 'unweighted cost-benefit analysis', has two major limitations. First, it makes no allowance for variation between individuals in the conversion rate from income to wellbeing – i.e. the marginal utility of income. Second, it provides no information about the social distribution of costs and benefits and the resulting impacts of policies on social inequalities. Public polices and institutions often have important distributional equity objectives relating to the reduction of social inequalities. Decision makers are thus interested to know whether policy options are likely to increase or reduce social inequalities, and by how much.

The fundamental problem with the conventional approach is that it fails to measure wellbeing impacts accurately. There is substantial variation between people in how far changes in income impact upon their wellbeing. Two particularly important sources of variation are that (1) an extra dollar does more to improve the wellbeing of a poor person than a rich person, and (2) an extra dollar is no use to anyone after their death. To take an extreme example, consider elderly billionaire Adam with end-stage cancer and young pauper Bob with a painful and disfiguring skin disease that renders him unable to work, socialise or enjoy physical intimacy. Bob is not able to pay one dollar for an extra fifty years of healthy life free of skin disease. By contrast, Adam is willing to pay a billion dollars for an extra three months of life undergoing debilitating chemotherapy. This is not because he or anyone else thinks these extra three months of life will be wonderful. Rather, it is because he is extremely rich, cannot take the money with him, and does not want to give the money away. Unweighted cost-benefit analysis values both treatments at something approaching the respective willingness to pay of both individuals, though somewhat less due to the administrative costs and 'deadweight' losses of raising new public funds through taxation. It therefore implies that the government should be willing to spend something approaching a billion dollars of public money for Adam's extra three months of unhealthy life, but should not be willing to spend a dollar giving Bob a healthy life for the next fifty years. When applied in a thoroughgoing manner, therefore, valuing policies in terms of people's willingness to pay may not accurately reflect strength of preference and can have ethically and politically unacceptable implications. This is not quite so stark in practice because instead of looking at each individual's willingness to pay, a substantial amount of averaging takes place. However, this averaging is an *ad hoc* move that is not justified by the underlying theory and only partly alleviates the problems.

We propose the wellbeing QALY as a practical way of addressing these limitations. Our proposal can be seen as a practical application of the theoretical frameworks for economic evaluation developed by Broome (Broome, 1991, Broome, 2004) and Adler (Adler, 2012). A key feature of these frameworks is that they are based on a set of explicit value judgements, some of which are formulated mathematically in the form of a 'social welfare function'. This contrasts with what we might call the 'Paretian' philosophy of welfare economics underpinning unweighted cost-benefit analysis, as advocated in health economics for example by Pauly (Pauly, 1996, Pauly, 1995).

The Paretian approach seeks to minimise the need for explicit value judgements. Of course, when making normative claims it is never possible to avoid value judgements altogether. For example, the Paretian approach makes a value judgement about the nature of wellbeing (i.e. that wellbeing consists in preferences, rather than experienced happiness or objective goods) and about the comparison of social states (i.e. that state A is a 'Pareto improvement' compared with state B if at least one person prefers A and no-one prefers B). In practice, it makes a substantially more

controversial value judgement based on the idea of a 'potential' Pareto improvement. The idea is that a policy change is worthwhile if the winners (in the example above, Adam the billionaire) can hypothetically compensate the losers (Bob, the pauper) so that everyone is better off. This is controversial, because the compensation is not actually paid in practice and often cannot be paid even in theory due to imperfect information, transaction costs and other market imperfections (Blackorby and Donaldson, 1990). This means that the Paretian approach systematically prioritises improvements to the wellbeing of the wealthy over improvements to the wellbeing of the poor, in rough proportion to difference in ability to pay — something that conflicts with most people's intuitive value judgments.

The Paretian approach can be contrasted with what we might call the 'social choice' philosophy of welfare economics (Adler and Fleurbaey, 2016), as advocated for example by Atkinson (Atkinson, 2011, Atkinson, 2009), Sen (Sen, 1999) and Fleurbaey and Schokkaert (Fleurbaey and Schokkaert, 2013) and in health economics by Williams (Williams, 1972) and Culyer (Cookson and Claxton, 2012). The 'social choice' approach seeks to make explicit value judgements about social objectives, and to subject those value judgements to public scrutiny and deliberation. For example, Fleurbaey and Schokkaert write that: "When one aims at policy evaluation, it is better to make the underlying value judgments as open as possible. Having an informed debate about such value judgments in a formal model has always been the main objective of social choice theory." (Fleurbaey and Schokkaert, 2013). The idea is that economic evaluation aims to provide social decision makers and stakeholders with useful information about how far alternative decision options are likely to achieve their objectives. The appropriate set of value judgements and policy objectives is ultimately a matter for the legitimate social decision maker to specify. However, alternative sets of value judgements can be explored in sensitivity analysis to help decision makers and stakeholders think through the implications of policies in a deliberative decision making process. In this way, economic evaluation using a 'social choice' approach can be seen as a contribution towards democracy in the broad sense of 'the exercise of public reason' (Sen, 2003, Sen, 2011).

Measuring individual wellbeing

We can distinguish 'period-specific wellbeing' during a specific time period from 'lifetime wellbeing' over the entire lifecourse. Lifetime wellbeing is generally what social decision makers ultimately care about, but it is harder to measure than period-specific wellbeing. We propose to treat lifetime wellbeing as the sum total of period-specific wellbeing over the individual's lifetime. This assumption of additive separability of wellbeing over time is standard practice in economics and agrees with some theories of lifetime wellbeing in the philosophical literature (Broome, 2004).

We propose measuring period-specific wellbeing as the time spent alive during that period, adjusted for overall quality of life during that period. We estimate quality of life during the period as a function of both health and income during that period. For convenience, we use one year as the standard time period. The choice of period does raise issues of value judgement, however, since additive separability over time becomes less plausible over short periods of time. For example, imagine time periods were measured in minutes. Straight after consuming a hearty meal, your wellbeing is likely to depend more on consumption in the previous few minutes, and perhaps on anticipated consumption later in the day, than on consumption in the current minute. This kind of issue is less problematic when consumption is measured over a year, or perhaps even over a month. However, parallel arguments can of course be made that there may be 'spillovers' in wellbeing effects from one year to another and that the pattern of wellbeing over a lifetime matters.

We propose to anchor the wellbeing QALY at 0 and 1 in a way that makes it compatible with the health QALY, and allows us to interpret 1 as a year of good life. It is desirable that our wellbeing QALY numbers agree with the data used to produce the health QALY weightings, for the people who were the source of these data, at least as far as agreeing whether a given health state is better or worse than death. More specifically, we propose that a score of 1 represents a year of life that is lived in full health while enjoying the high living standards – by global historical standards – of the average person in a modern high income country. And a score of 0 represents a year of life in a severely ill state of health that the average person considers to be 'no better than death, given their current (average) level of income.[4] This aligns the scale with the health QALY scale, and facilitates the use of existing data on health-related quality of life in the construction of the wellbeing QALY.

We do not propose bounding the scale at 0 and 1, however. This means that values below 0 and above 1 are allowed, reflecting the possibility of states of health that are worse than death, and states of income that are better than the standard level of income in a high income country. We say more below about how both 'good quality life' and 'life barely worth living' might be defined and measured. In line with our 'social decision making' philosophy, these definitions are value judgements about the appropriate objective of social policy, and are ultimately a matter for the legitimate social decision maker to specify.

So far, everything is almost exactly the same as the health QALY in mathematical terms – except that we have re-interpreted period-specific quality of life as 'overall quality of life' rather than 'health-related quality of life', and have allowed scores greater than one. The key innovation is that we now propose to measure period-specific quality of life as a function of income as well as health.

In reality, of course, quality of life depends on a lot more than just income and health. But we are simplifying for practical purposes, since income and health are two important components of quality of life that are influenced by public policy, that are of substantial concern to policy makers, and that are readily measurable. Our proposal allows other important public policy outcomes, such as education outcomes, crime outcomes, and so on, to be valued in two ways. First, *indirectly*, via long-

---

[4] An alternative would be to set 0 as a combination of this severely ill state of health along with a minimal level of income.

term impacts on the individual's income and health over the lifecourse. Second, *directly* by monetising these outcomes using willingness to pay, just as in traditional cost-benefit analysis, and then converting the corresponding monetary benefits into years of good life gained.

Although our two-dimensional approach to measuring period-specific wellbeing may seem simple, it is more demanding in terms of data requirements than unweighted cost-benefit analysis as commonly practiced. This is because to estimate wellbeing impacts we need to know not only the 'average' effects on income and health for the 'average' person, but also (1) the distribution of baseline income and health between different social groups, and (2) the distribution of effects on income and health between different groups and over the whole lifetime of the individual. In theory, unweighted cost-benefit analysis does also need to allow for both (1) and (2), since willingness to pay will depend on baseline income and health. In practice, however, this is almost never done – instead, analysts simply work with averages.

Mathematically, we can specify an individual lifetime wellbeing function as follows:

$$w_i = \sum_t w(c_{it}, h_{it}) \qquad\qquad (1)$$

$$\text{where}$$

w_i is the lifetime wellbeing of individual i
w_{it} is the period-specific wellbeing or quality of life or individual i
c_{it} is the income (or consumption) of individual i in period t
h_{it} is the health quality of individual i in period t.

Income can be measured in real financial resources – such as dollars in a given year. Health quality[5] h_{it} is a function $h(\mathbf{H_{it}})$ of $\mathbf{H_{it}}$, a multi-dimensional vector of the health attributes of individual i in period t. Whereas $\mathbf{H_{it}}$ is highly multidimensional, h_{it} is a scalar – we assume it is measured on the standard scale of the health QALY, bounded above at 1, where 1 represents full health and 0 represents death or a health state as bad as death. A key assumption here is that the interaction between health states and income operates only through health quality, such that wellbeing only depends on health quality and income and not also upon the pattern of underlying multidimensional health states. This assumption might be violated, for example, if mental and physical dimensions of health interact with income in different ways to produce wellbeing. For example, a person with depression might have the same quality of health score as a person with severe osteoarthritis, but their wellbeing may be less sensitive to income if their depressed state of mind prevents them enjoying the consumption of goods and services.

The period-specific wellbeing function $w_{it}(c_{it}, h_{it})$ is monotonically increasing in both variables. To measure this empirically, however, some further specification is necessary.

One possibility is the following simple additive wellbeing function, decomposing wellbeing into the utility of health and the utility of income:

$$w_{it} = h_{it} + u(c_{it}) \qquad\qquad (2)$$

---

[5] We use the phrase 'health quality' to emphasise that this is not a 'value-free' physical quantity of health, but rather is a value-laden index of health-related quality of life that requires value judgements both in selecting and describing the relevant dimensions of health and in combining measurements of the different health dimensions to generate an overall score. We do not take sides in the philosophical debate about whether this number is more appropriately referred to as 'health' or as 'the value of health'.

u(c_{it}) is a standard isoelastic utility of income function defined as follows:

$$u(c_{it}) = A - B \times (c_{it})^{1-\eta} \qquad (3)$$

A and B are normalisation constants defined as follows in order to anchor the scale appropriately at 0 and 1:

A = $C_{min}^{(1-\eta)}$ / ($C_{min}^{(1-\eta)}$ - $C_{std}^{(1-\eta)}$)

B = 1 / ($C_{min}^{(1-\eta)}$ - $C_{std}^{(1-\eta)}$)

- η >1 ("eta") is a normative parameter representing the diminishing marginal value of income
- c_{min} is minimal consumption, defined as the lowest possible level of income at which life is considered worth living for an individual in full health.
- c_{std} is standard income, defined as the income of the average individual in a modern high income country

The higher the eta parameter, η, the more rapidly diminishing returns set in as consumption increases. The theoretical literature on isoelastic functions supports the possibility that $\eta \leq 1$, in which case the wellbeing function is not bounded above. However, the empirical literature supports values of η of at least 1. Based on a study of the association between subjective wellbeing and consumption by Layard and colleagues, using four large cross-sectional surveys of subjective happiness and two panel surveys from multiple countries between 1972 and 2005 one reasonable assumption might be eta equals 1.26 (Layard et al., 2008).

Our proposal is to set minimal income around the level of subsistence income. For example, one might start with the World Bank's current absolute global poverty line of $1.90 a day in 2011 prices (updating the previous line of $1.25 a day in 2005 prices), corresponding to $693.50 per year in 2011 prices[6]. Since we normally think that healthy lives in extreme poverty are worth living, we think c_{min} should be below this level. So in the example below we use a value of c_{min} = $300 per year, which is a little under half the World Bank poverty line.

For C_{std}, we use a value of $30,000 US dollars for the USA in 2014, based on the following calculation. In 2014, US median household income before taxes and benefits was $53,657, average household size was 2.6 and 23% of the population were children (aged 0 to 17).[7] We can thus think of the average household as comprising 2 adults and 0.6 of a child. To allow for household size and composition, the standard equivalence scale used in the US for this kind of household is (adults + 0.5*children)$^{0.7}$ which yields a scale of 1.79[8]. Dividing household income by 1.79 then gives us a figure of $29,951 for individual income, which we round up to $30,000.

We use this figure for convenience, as ideally one would want a figure after taxes and benefits and including the value of 'in kind' benefits and services from the state and family. This figure is not an unreasonable starting point, however, insofar as the taxes paid to the state by the typical household can be assumed approximately equal in value to the cash and noncash benefits received from the

---

[6] See http://documents.worldbank.org/curated/en/2015/10/25114899/global-count-extreme-poor-2012-data-issues-methodology-initial-results

[7] Data sources: (1) http://www.census.gov/content/dam/Census/library/publications/2015/demo/p60-252.pdf
(2) https://www.census.gov/prod/cen2010/briefs/c2010br-14.pdf
(3) http://www.childstats.gov/americaschildren/tables/pop2.asp?popup=true; all accessed 17 May 2016.

[8] Source of equivalence scale https://www.census.gov/content/dam/Census/library/publications/2014/demo/p60-251.pdf; accessed 17 May 2016.

state. It will nevertheless underestimate the broad concept of individual income that we would ideally wish to measure, since it excludes the value of informal household services such as cooking, cleaning, childcare and so on.

Figure 1 shows what the resulting relationship between period-specific wellbeing and consumption for someone in full health would look like, under these parameter assumptions.
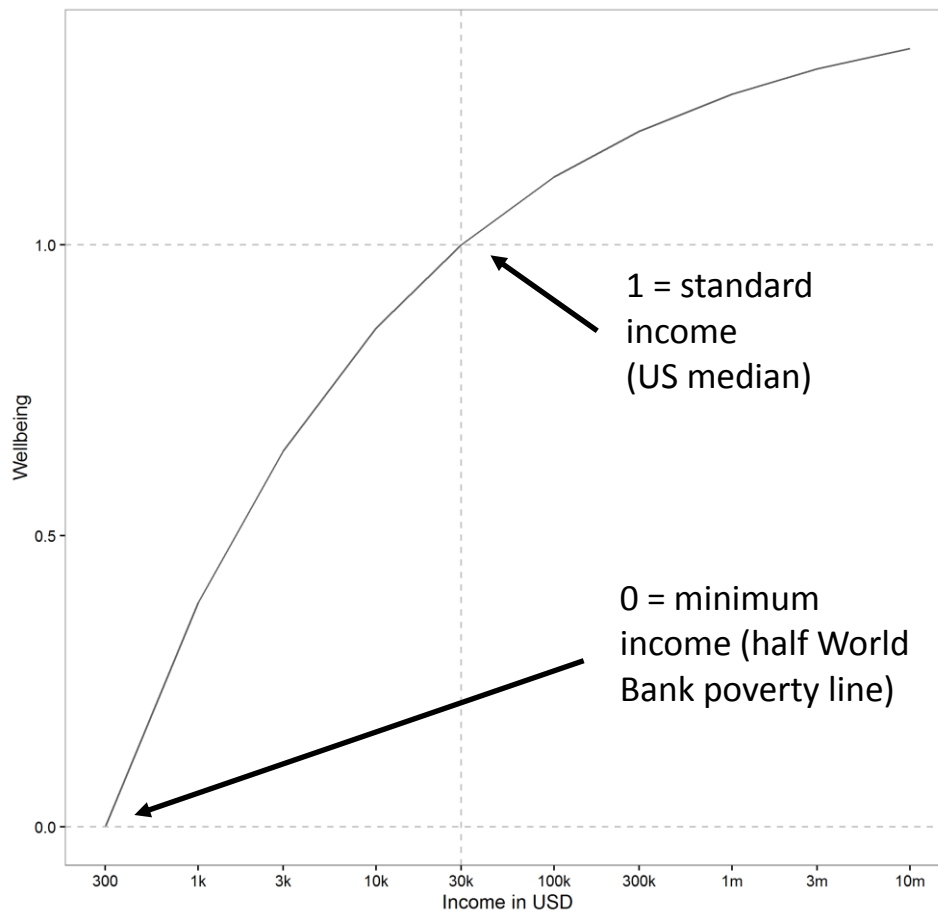
Figure 1: Wellbeing value of income in full health (η = 1.26)

Note: Income is shown on a log scale, and represents annual individual income after tax from all sources, including the imputed value of non-market services provided by state and family.

We do not show wellbeing scores for consumption below subsistence income, since by definition individual income cannot fall below the subsistence level for long periods of time. Subsistence income is well below the minimal level of income that a modern high income country government would consider acceptable for its poorest citizen. This is because the market price of basic food and shelter is substantially more than $1 a day in any high income country location, and our concept of income includes the imputed market value of goods and services provided free by the state, family and others. So living on subsistence income would require avoiding offers of food and shelter from the state, family or others. It would require living like a lone wild animal: sleeping rough, foraging for food, and avoiding almost all social contact.

An alternative assumption would be to set C_{min} around the minimal level of income considered acceptable for the poorest citizen in a high income country, for example the income of an unemployed adult with no private wealth who relies entirely on benefits and services provided by the state. To illustrate the implications of this alternative assumption, Figure 2 below explores the value of C_{min} = $10,000 per year. This assumption implies that human life is barely worth living as

the poorest citizen in a high income country. By contrast, the subsistence income approach implies that human life is barely worth living as a lone wild animal.
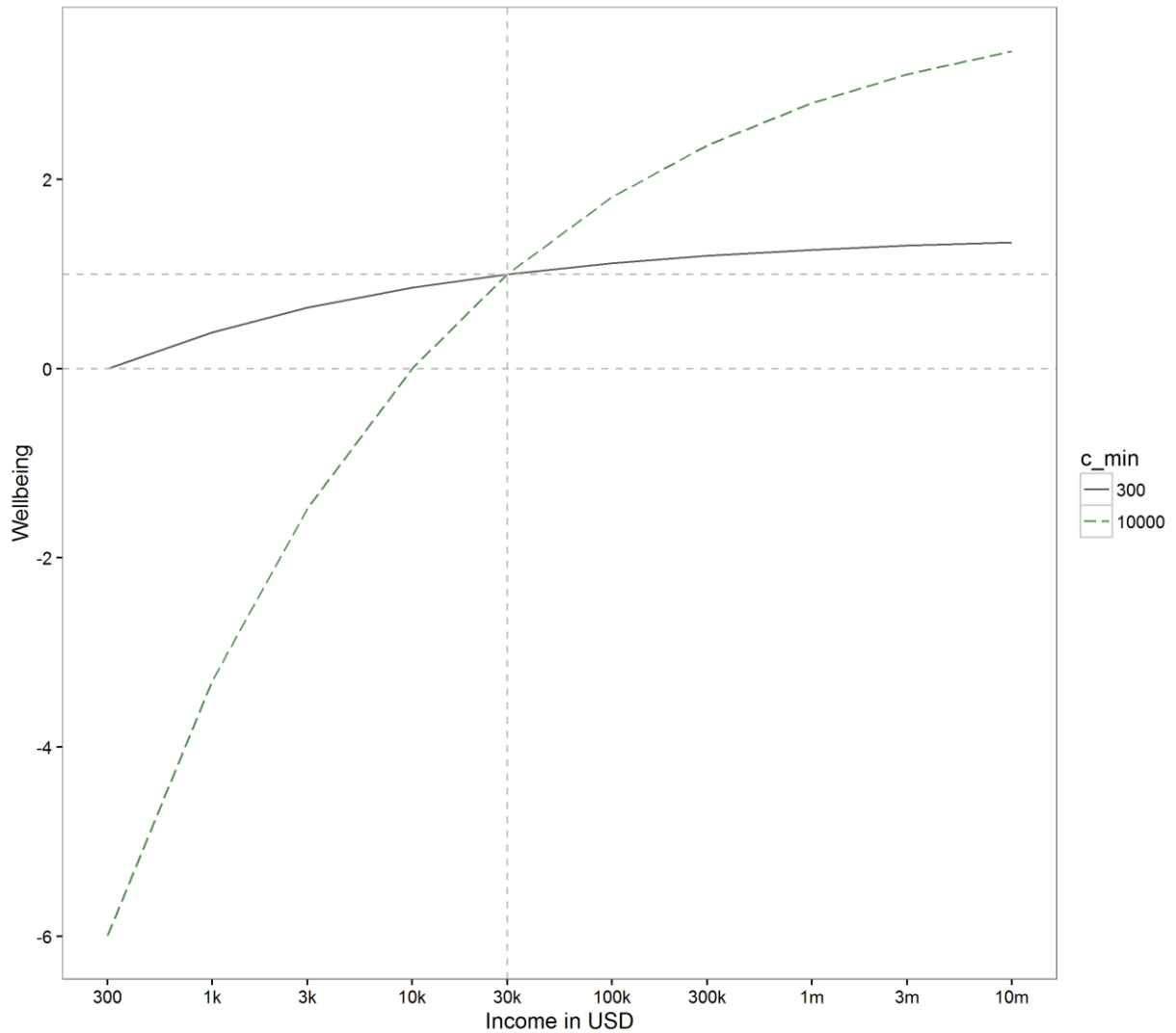

Figure 2: Wellbeing under alternative assumptions about minimal income (η = 1.26)

Allowing for interactions between income and health

The simple additive wellbeing function assumes the marginal benefit of consumption does not depend on ill health (Bleichrodt and Quiggin, 1999, Smith and Keeney, 2005, Hammitt, 2013). An alternative view might be that the marginal benefit of consumption increases with ill health. For example, additional income may bring substantial benefits to someone unable to walk, in allowing them to purchase mobility equipment and a variety of transport, communication and personal care services. Yet another view might be that the marginal benefit of consumption decreases with ill health. For example, additional income may bring limited benefits to someone who is severely depressed and no longer able to enjoy the good things in life.

To allow for these possibilities, a more general wellbeing function would have the following form, based on a weighted average of additive and multiplicative functional forms:

$$w_{it} = \alpha + \alpha.h_{it}.u(c_{it}) + (1 - \alpha)\big(h_{it} + u(c_{it})\big) - 1 \quad (4)$$

where
- $u(c_{it})$ is the wellbeing of consumption in full health.
- α is a consumption-health interaction parameter, bounded above by 1 to ensure that the marginal utility of consumption is always positive.

When $\alpha = 0$, this reduces to the additive form in equation (3). When $\alpha > 0$ the marginal benefit of consumption decreases with ill health, so that health and consumption function like economic complements. When $\alpha < 0$ the marginal benefit of consumption increases with ill health, so that health and consumption function like economic substitutes. This form is uniquely determined by the assumptions that: (i) the gambles people would accept over consumption levels are independent of quality of health state; (ii) the gambles people would accept over health states excluding death are independent of consumption level; and the boundary conditions (iii) if u(c)=h=1 then w = 1; (iv) if u(c)=1, h=0, then w = 0; and (v) if u(c)=0, h=1, then w = 0. There is not much empirical evidence about this issue (Evans and Viscusi, 1991, Rey and Rochet, 2004), but one study suggested a positive value (Viscusi and Evans, 1990) whereas a more recent study supports a negative value of alpha of around -1 (Tengstam, 2014).

In practice, we would therefore propose using a base case assumption of alpha = 0, for convenience and simplicity, and then sensitivity analysis around alternative plausible values such as alpha = 0.5 (in the middle of the possible range up to 1) and alpha = -1.

Figure 3 shows how wellbeing changes with different levels of health under different assumptions about alpha, returning to our base case assumption that minimal income is subsistence income.[9] The lowest health quality score in figure 3 is -0.281, reflecting the lowest score from the latest EQ-5D-5L health value set for England (Devlin et al., 2016).

---

[9] A web-based application for drawing further graphs of this kind based on different parameter values is available here
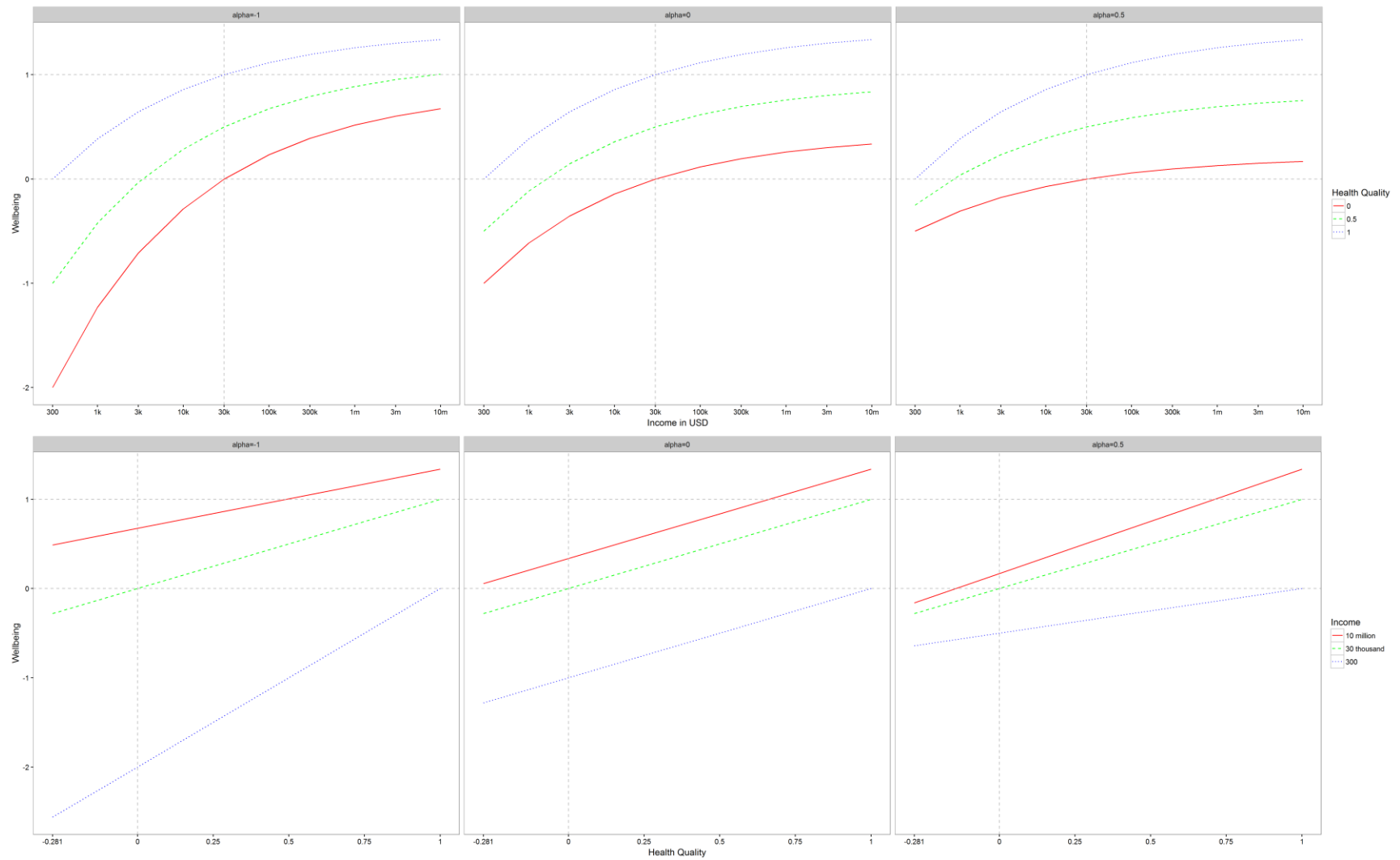https://miqdadasaria.shinyapps.io/wellbeing_adjusted_life_years/

Figure 3: Wellbeing as a function of income and health with different values of alpha (η = 1.26 and C$_{min}$ = 300)

Measuring population average lifetime wellbeing

To compare the outcomes of alternative social policies, we need to aggregate individual wellbeing outcomes to the population level. The simplest way of doing this is just to take the average of individual wellbeing outcomes – i.e. to calculate average lifetime wellbeing. As is standard practice in economic evaluation, we assume that the population is stable and set aside the thorny issue of how to value population change.

Our proposal allows average lifetime wellbeing to be measured on a ratio scale, in the same way that consumption can be measured on a ratio scale. Unlike an interval scale (e.g. degrees Fahrenheit), a ratio scale has an absolute zero and so it makes sense to calculate ratios and percentage differences. As well as being useful for economic evaluation, this is also useful for measuring social progress, since a ratio scale allows the calculation of percentage changes in a society's average lifetime wellbeing over time, and percentage differences in average lifetime wellbeing between different societies. Not all measures of social progress allow this. For example, the concept of 'full national income' augments standard measures of change in national income by adding in the monetary value of changes in population health over time (Jamison et al., 2013) (see, in particular, supplementary web appendix 3 http://globalhealth2035.org/report/supplementary-web-appendices). Unfortunately, however, this only allows one to calculate changes in full national income over time, not baseline levels of full national income. So unlike wellbeing QALYs, the concept of 'full national income' does not allow comparison of percentage changes over time or percentage differences between societies.

Measuring social inequality in lifetime wellbeing

Our approach to measuring lifetime wellbeing already embodies one important type of concern for social inequality. The wellbeing QALY embodies an assumption of diminishing marginal value of consumption. It thus embodies the same form of concern for inequality in consumption as classical utilitarianism. The utilitarian case for redistribution is that a dollar of consumption is worth less to a rich person than a poor person – hence, other things equal, taking a dollar from a rich person and giving it to a poor person will tend to increase sum total wellbeing.

However, policymakers may have additional concerns for social inequality in lifetime wellbeing, as well as inequality in current consumption. Our wellbeing QALY metric is well suited to analysing such concerns, for three reasons. First conducting separate analyses of inequality in different components of wellbeing – e.g. inequality in consumption and inequality in health – may be misleading, insofar as different components of wellbeing can compensate for one another (Adler, 2012, Fleurbaey and Schokkaert, 2009). Second, a ratio scale measure of individual lifetime wellbeing allows the use of standard indices of relative inequality based on percentage differences between individuals. Third, the wellbeing QALY is well suited to analysing trade-offs between 'efficiency' in terms of average wellbeing versus 'equity' in terms of reducing inequality in the social distribution of lifetime wellbeing. The wellbeing QALY metric allows the use of standard social welfare functions to analyse equity-efficiency trade-offs of this kind. Standard social welfare functions can be expressed in the following abbreviated or reduced form (Adler, 2012):

$$W = \bar{w} * (1 - I(\boldsymbol{w}, \varepsilon))$$

where
W is social welfare
$\boldsymbol{w}$ is a vector of the individual lifetime wellbeing of all individuals or groups in society
$\bar{w}$ is mean individual lifetime wellbeing across the whole population
I(.) is an inequality index scaled from 0 to 1 (where 0 is full equality and 1 full inequality)
ε is an inequality aversion parameter

One plausible functional form for the inequality index is the Atkinson function (Adler, 2012) (see Chapter 5). In the Atkinson function, $\varepsilon = 0$ represents zero aversion to inequality in which case I = 0. Higher values of ε imply greater weight to the worse off i.e. those with lower lifetime wellbeing. Finally, an infinite value of ε implies exclusive priority to the worst off individual or group – i.e. a 'maximin' principle. Once ε has been specified, it is then possible to compare populations and policies in terms of overall social wellbeing, and to analyse trade-offs between changes in average lifetime wellbeing, $\bar{w}$, and changes in inequality, I.

An extension of this approach is to adjust the vector of lifetime wellbeing as appropriate to focus on 'unfair' determinants of individual wellbeing (e.g. parental class or race) and to set aside 'fair' determinants (e.g. personal responsibility) and determinants that are neither 'fair' nor 'unfair' (e.g. misfortunes considered a matter of personal tragedy rather than social injustice) (Fleurbaey and Schokkaert, 2009, Adler, 2012, Fleurbaey and Schokkaert, 2011, Asada et al., 2015, Ferriera and Peragine, 2016) (see Chapter 8 of Adler).

Analysing inequality in lifetime wellbeing QALYs does not preclude performing additional forms of distributional analysis. Decision makers may still want to have information about dimension-specific

inequality in consumption, for example if they have non-utilitarian concerns about inequality in consumption. And they may want information about dimension-specific inequality in health if they have special concerns for inequality in health. For example, in 1997, the then UK Secretary of State for Health Frank Dobson said that "Health inequality is the worst inequality of all. There is no more serious inequality than knowing that you'll die sooner because you're badly off." (http://www.lgcplus.com/govt-takes-action-to-reduce-health-inequalities/1494985.article). Our framework complements dimension-specific analyses of this kind, by analysing interactions between consumption, health and wellbeing and placing the analysis within a more general framework.

Discussion

We have proposed a practical way of evaluating public policies by combining data on consumption, health and longevity to measure years of good life. The 'wellbeing QALY' could in principle be used in any type of economic evaluation, including both cost-effectiveness analysis and cost-benefit analysis. Cost-effectiveness analysis using wellbeing QALYs would assume an exogenously fixed public budget – i.e. no scope for raising taxes or finding other new sources of public finance. It would then compare social policies on the basis of which way of spending that fixed budget yields the most years of good life. Cost-benefit analysis would go beyond this by allowing the possibility of raising taxes and changing the public budget – and it would value those taxation costs, along with all other costs and benefits, in terms of their impacts on years of good life. Either way, it would be important to know where the opportunity costs of social policies fall – for example, which public budget(s) will be used to finance the policy. This is because different sources of funding will have different implications for who bears the opportunity costs of the policy in terms of reduced income (including reductions in 'in kind' consumption of public services) – and hence the impact on years of good life.

The attractive features of our approach are:

1.   It builds on well-understood concepts, data and methods already extensively used to inform decision making in the health sector
2.   It uses a simple, intuitive metric – years of good life
3.   It requires only readily available data on income, health and longevity
4.   It facilitates clarity about policy objectives and value judgements
5.   It allows decision makers to explore the implications of alternative policy objectives and value judgements
6.   It allows analysis of percentage changes and equity-efficiency trade-offs

The main disadvantages of our approach compared with conventional unweighted cost-benefit analysis are:

1.   It has more demanding requirements for explicit modelling of income and health distributions
2.   It has more demanding requirements for explicit social value judgement

Our approach requires explicit modelling of distributions of income and health by population sub-group over the life course, as well as average effects on income and health. Although more demanding in terms of data and assumptions, this kind of modelling is becoming ever more feasible in the age of 'big data' (Layard et al., 2014, Wolfson, 1995, Wolfson and Rowe, 2013, Wolfson and Rowe, 2014). Furthermore, a thoroughgoing application of conventional cost-benefit analysis would also require modelling of these distributions, since willingness to pay depends on baseline income and health. It is just that in practice this explicit modelling is rarely if ever done – instead, the analysis relies upon implicit factual assumptions.

In terms of social value judgement, the simplest implementation of our approach requires explicit specification of three new normative parameters:

1.   Diminishing marginal value of income, λ
2.   Minimal income, c_{min}

3. Standard income, c_{std}

These three parameters specify how much wellbeing is derived from any given level of income. The first specifies the degree of curvature in the curvilinear relationship between income and wellbeing, the second specifies where it crosses the horizontal axis at zero wellbeing, and the third specifies the level of income in full health that is considered to represent a year of good life. Taken together, these parameters tell us how much change in wellbeing is derived from a one dollar change in income, and how this varies for people with different baseline levels of income.

A fuller implementation of our approach requires two further normative parameters:

4. Income-health interaction, α
5. Inequality aversion, ε

The fourth parameter, α, allows for interactions between health and income in determining wellbeing. And finally, the inequality aversion parameter, ε, allows the analysis to incorporate the value of reducing inequality in lifetime wellbeing as well as the value of increasing sum total lifetime wellbeing.

Like other normative parameters in economic evaluation – such as the appropriate discount rate for benefits accruing to future generations, or the monetary value of a life year – these parameters are ultimately a matter for value judgement by the relevant social decision maker(s), after a due process of public deliberation. However, to help guide this process of deliberation, empirical 'benchmarks' can be found for all five parameters – for example using data on life satisfaction for 1 and 4, data on average and subsistence levels of income for 2 and 3, and data on public views for 5. Furthermore, the implications of different value judgements on all five parameters can be explored in sensitivity analysis.

The leading alternative to the 'years of good life' approach is the 'equivalent income' approach (Fleurbaey et al., 2013). This approach retains money as the metric of value, but uses a system of distributional weights to adjust raw willingness to pay amounts. The distributional weights are based upon (1) a normative inequality aversion parameter, and (2) a preference-based measure of equivalent income, defined as the level of income in full health and at a reference level of other dimensions of wellbeing that the individual considers equally as good as their current level of income, health and other dimensions of wellbeing. Equivalent income can be estimated, for example, through a survey exercise asking people their willingness to pay for full health. This approach has similarly demanding distributional modelling requirements to the wellbeing QALY approach. The main advantage of the equivalent income approach is that it is more respectful of individual preferences. Instead of making normative assumptions about the rate of conversion between income, health and wellbeing, it relies upon survey data on how much people are actually willing to pay for full health. The main disadvantages are that distributionally-weighted willingness to pay figures (1) cannot be interpreted on a ratio scale, and (2) are somewhat unintuitive for policy makers – it is not clear what a 'distributionally weighted' dollar means. Of course, there are similar risks with the concept of 'years of good life', which decision makers may initially find unintuitive. However, experience in the health field has shown that decision makers are capable of understanding and using the QALY concept in practice, despite initial qualms.

The wellbeing QALY approach could be adjusted in order to reflect individual preferences as closely as possible, however, by adjusting the normative parameters in line with empirical evidence about individual preferences regarding income and consumption. However, there is a limit to how any

approach that imposes a coherent logical structure on social valuations can reflect individual preferences. This is because cognitive psychologists and behavioural economists have amassed considerable evidence from both laboratory and field experiments that individual preferences are incoherent – for example, individual willingness to pay is often influenced by apparently irrelevant factors such as 'priming' and 'framing' effects (Kahneman, 2011, Sugden, 2008).

O'Donnell and colleagues have proposed a different way of operationalising the concept of years of good life, which we might call the life satisfaction QALY. They propose to measure period-specific wellbeing directly, using data on life satisfaction, rather than indirectly using data on consumption and health. Data on life satisfaction are collected in surveys, usually on a scale of 0 to 10, using questions like the following one from the 1970 British Cohort Study:

"Here is a scale from 0 to 10, where '0' means that you are completely dissatisfied and '10' means that you are completely satisfied. Please enter the number which corresponds with how satisfied or dissatisfied you are with the way life has turned out so far"

O'Donnell and colleagues propose taking this data, dividing by 10, and interpreting the resulting 0 to 1 index as a ratio scale where 0 is a quality of life as bad as death and 1 is a fully satisfactory quality of life. An advantage of this approach is that it measures (subjective) wellbeing directly rather than relying on a modelled estimate based on other variables. It thus avoids a limitation with our approach, which is that an individual's rate of conversion from income to wellbeing may depend on individual characteristics other than just income and health. A disadvantage of this approach, however, is that the interpretation of life satisfaction data as a ratio scale is an *ad hoc* assumption that so far has not been subjected to psychometric testing – in contrast to the huge literature on developing and testing ratio scale measures of health quality (Brazier, 2007). This assumption may work as an approximation, but there is little reason to think that the wellbeing difference between say 3 and 4 as a survey answer is the same as the difference between 7 and 8. Another issue is that the research community has less experience using data on life satisfaction to measure policy impacts than data on income and health, and there are many potential biases around issues such as expectations and adaptation that have not yet been fully explored in the context of policy evaluation (Fujita and Diener, 2005, Lucas, 2007, Di Tella and MacCulloch, 2006). A final disadvantage is that data on income and health outcomes are more frequently collected at present than data on the effects of interventions on subjective wellbeing.

Table 1: Key features of the three leading alternatives to conventional cost-benefit analysis

Approach	Main normative data sources	Main normative parameters	Metric	Respects preferences?	Ratio scale?
Wellbeing QALY	Income, health	Elasticity of marginal utility of income, standard income, minimal income	Years of good life	No	Yes
Life satisfaction QALY	Life satisfaction	None – though embodies normative assumptions in treating ordinal data as a ratio scale	Years of good life	No	Yes
Equivalent income	Willingness to pay for full health	Inequality aversion	Distributionally weighted money	Yes	No

Despite these differences, our proposal for wellbeing QALYs, the O'Donnell proposal for life satisfaction QALYs, and the equivalent income approach all share a key similarity: they all require models of the long-term effects of policies on different dimensions of wellbeing for different types of individual. A key next stage in research will therefore be to develop micro simulation models of wellbeing over the life course and use them to apply these three approaches alongside standard unweighted cost-benefit analysis.

References

ADLER, M. D. 2012. *Well-Being and Fair Distribution : Beyond Cost-Benefit Analysis,* New York, Oxford University Press.

ADLER, M. D. & FLEURBAEY, M. (eds.) 2016. *The Oxford Handbook of Well-Being and Public Policy*: Oxford University Press.

ASADA, Y., HURLEY, J., NORHEIM, O. & JOHRI, M. 2015. Unexplained health inequality - is it unfair? *International Journal for Equity in Health,* 14**,** 11.

ATKINSON, A. B. 2009. Economics as a moral science. *Economica,* 76**,** 791-804.

ATKINSON, A. B. 2011. The restoration of welfare economics. *The American Economic Review***,** 157-161.

BLACKORBY, C. & DONALDSON, D. 1990. A review article: The case against the use of the sum of compensating variations in cost-benefit analysis. *Canadian Journal of Economics***,** 471-494.

BLEICHRODT, H. & QUIGGIN, J. 1999. Life-cycle preferences over consumption and health: when is cost-effectiveness analysis equivalent to cost–benefit analysis? *Journal of Health Economics,* 18**,** 681-708.

BRAZIER, J. 2007. *Measuring and Valuing Health Benefits for Economic Evaluation*, Oxford University Press.

BROOME, J. 1991. *Weighing Goods : Equality, Uncertainty, and Time,* Cambridge, Mass., Basil Blackwell.

BROOME, J. 2004. *Weighing Lives,* Oxford ; New York, Oxford University Press.

COOKSON, R. 2005. QALYs and the capability approach. *Health Economics,* 14**,** 817-829.

COOKSON, R. & CLAXTON, K. 2012. The Humble Economist: Tony Culyer on Health. *Health Care and Social Decision Making. York and London: University of York and Office of Health Economics*.

COOKSON, R. & CULYER, A. 2010. Measuring overall population health: the use and abuse of QALYs. *In:* KILLORAN, A. & KELLY, M. (eds.) *Evidence-Based Public Health: Effectiveness and Efficiency.* Oxford: Oxford University Press.

DEVLIN, N., SHAH, K., FENG, Y., MULHERN, B. & VAN HOUT, B. 2016. Valuing Health-Related Quality of Life: An EQ-5D-5L Value Set for England.

DI TELLA, R. & MACCULLOCH, R. 2006. Some uses of happiness data in economics. *The Journal of Economic Perspectives,* 20**,** 25-46.

EVANS, W. N. & VISCUSI, W. K. 1991. Estimation of state-dependent utility functions using survey data. *The Review of Economics and Statistics***,** 94-104.

FERRIERA, F. H. G. & PERAGINE, V. 2016. Individual Responsibility and Equality of Opportunity (Chapter 25). *In:* ADLER, M. D. & FLEURBAEY, M. (eds.) *The Oxford Handbook of Well-Being and Public Policy.* Oxford University Press.

FLEURBAEY, M., LUCHINI, S., MULLER, C. & SCHOKKAERT, E. 2013. Equivalent incomes and the economic evaluation of health care. *Health Econ,* 22**,** 711 - 729.

FLEURBAEY, M. & SCHOKKAERT, E. 2009. Unfair inequalities in health and health care. *Journal of Health Economics,* 28**,** 73-90.

FLEURBAEY, M. & SCHOKKAERT, E. 2011. Chapter Sixteen - Equity in Health and Health Care. *In:* MARK V. PAULY, T. G. M. & PEDRO, P. B. (eds.) *Handbook of Health Economics.* Elsevier.

FLEURBAEY, M. & SCHOKKAERT, E. 2013. Behavioral welfare economics and redistribution. *American Economic Journal: Microeconomics,* 5**,** 180-205.

FUJITA, F. & DIENER, E. 2005. Life satisfaction set point: stability and change. *Journal of Personality and Social Psychology,* 88**,** 158.

HAMMITT, J. K. 2013. Admissible utility functions for health, longevity, and wealth: integrating monetary and life-year measures. *Journal of Risk and Uncertainty,* 47**,** 311-325.

HOLMES, J., MENG, Y., MEIER, P. S., BRENNAN, A., ANGUS, C., CAMPBELL-BURTON, A., GUO, Y., HILL-MCMANUS, D. & PURSHOUSE, R. C. 2014. Effects of minimum unit pricing for alcohol on different income and socioeconomic groups: a modelling study. *The Lancet,* 383**,** 1655-1664.

JAMISON, D. T., SUMMERS, L. H., ALLEYNE, G., ARROW, K. J., BERKLEY, S., BINAGWAHO, A., BUSTREO, F., EVANS, D., FEACHEM, R. G. & FRENK, J. 2013. Global health 2035: a world converging within a generation. *The Lancet,* 382**,** 1898-1955.

KAHNEMAN, D. 2011. *Thinking, Fast and Slow*, Macmillan.

LAYARD, R., CLARK, A. E., CORNAGLIA, F., POWDTHAVEE, N. & VERNOIT, J. 2014. What Predicts a Successful Life? A Life-course Model of Well-being. *The Economic Journal,* 124**,** F720-F738.

LAYARD, R., MAYRAZ, G. & NICKELL, S. 2008. The marginal utility of income. *Journal of Public Economics,* 92**,** 1846-1857.

LUCAS, R. E. 2007. Adaptation and the set-point model of subjective well-being does happiness change after major life events? *Current Directions in Psychological Science,* 16**,** 75-79.

MEIER, P. S., HOLMES, J., ANGUS, C., ALLY, A. K., MENG, Y. & BRENNAN, A. 2016. Estimated effects of different alcohol taxation and price policies on health inequalities: a mathematical modelling study. *PLoS Med,* 13**,** e1001963.

O'DONNELL, G., DEATON, A., DURAND, M., HALPERN, D. & LAYARD, R. 2014. Wellbeing and Policy. London: Legatum Institute.

PAULY, M. V. 1995. Valuing health care benefits in money terms. *In:* SLOAN, F. (ed.) *Valuing Health Care: Costs, Benefits and Efectiveness of Pharmaceuticals and Other Medical Technologies.* Cambridge University Press.

PAULY, M. V. 1996. Reply to Anthony J. Culyer and Robert G. Evans. *Journal of Health Economics,* 15**,** 253-254.

REY, B. & ROCHET, J.-C. 2004. Health and wealth: How do they affect individual preferences? *The Geneva Papers on Risk and Insurance Theory,* 29**,** 43-54.

SEN, A. 1999. On ethics and economics. *OUP Catalogue*.

SEN, A. 2003. Democracy and Its Global Roots. *New Republic***,** 29.

SEN, A. 2011. *The idea of justice*, Harvard University Press.

SMITH, J. E. & KEENEY, R. L. 2005. Your money or your life: A prescriptive model for health, safety, and consumption decisions. *Management Science,* 51**,** 1309-1325.

SUGDEN, R. 2008. Why incoherent preferences do not justify paternalism. *Constitutional Political Economy,* 19**,** 226-248.

TENGSTAM, S. 2014. Disability and marginal utility of income: Evidence from hypothetical choices. *Health Economics,* 23**,** 268-282.

VISCUSI, W. K. & EVANS, W. N. 1990. Utility functions that depend on health status: estimates and economic implications. *The American Economic Review***,** 353-374.

WILLIAMS, A. 1972. Cost-benefit analysis: bastard science? And/or insidious poison in the body politick? *Journal of Public Economics,* 1**,** 199-225.

WOLFSON, M. & ROWE, G. 2014. Unjust Health Inequalities: an Analysis Based on Canada's National Population Health Survey and the HealthPaths Microsimulation Model. *IARIW 33rd General Conference.* Netherlands.

WOLFSON, M. C. 1995. Socio-Economic Statistics and Public Policy: A New Role for Microsimulation Modeling. *Statistics Canada Working Paper*.

WOLFSON, M. C. & ROWE, G. 2013. HealthPaths—Using health trajectories to estimate and simulate the relative importance of determinants of health-adjusted life expectancy (HALE): a statistical analysis. *The Lancet,* 381**,** S148.