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Life satisfaction, QALYs, and the monetary value of health

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ABSTRACT

The monetary value of a quality-adjusted life-year (QALY) is frequently used to assess the benefits of health interventions and inform funding decisions. However, there is little consensus on methods for the estimation of this monetary value. In this study, we use life satisfaction as an indicator of 'experienced utility', and estimate the dollar equivalent value of a QALY using a fixed effect model with instrumental variable estimators. Using a nationally-representative longitudinal survey including 28,347 individuals followed during 2002–2015 in Australia, we estimate that individual's willingness to pay for one QALY is approximately A$42,000-A$67,000, and the willingness to pay for not having a long-term condition approximately A$2000 per year. As the estimates are derived using population-level data and a wellbeing measurement of life satisfaction, the approach has the advantage of being socially inclusive and recognizes the significant meaning of people's subjective valuations of health. The method could be particularly useful for nations where QALY thresholds are not yet validated or established.

1. Introduction

The methods for assigning monetary value to health or quality-adjusted life-years (QALYs) form the foundation of the modern application of cost-effectiveness analysis, where a threshold is used to determine whether an intervention is cost-effective and the resulting recommendations for funding. A recent systematic review on willingness to pay for a QALY (Ryen and Svensson, 2015) identified 24 published studies, with the overwhelming majority using the stated preference method, such as various forms of contingent valuation which uses hypothetical questions to directly ask about individual's willingness to pay to move between health states. As the review by Ryen and Svensson (2015) highlights these studies have produced a wide range of estimates for the willingness to pay for a QALY with a mean across all studies being €118,839 and a median of €24,226.

A different, but growing literature uses subjective wellbeing valuation methods to calculate the shadow price of health. Compared with stated preference methods which rely on expected utility under hypothetical scenarios, the well-being valuation method examines the impacts of life circumstances based on revealed preference (for a more detailed discussion on stated and revealed preference methods, see for instance Dolan and Kahneman, 2008; Mark and Swait, 2004; and McPherson et al., 2004). Examples of well-being valuation studies include Ferrer-i-Carbonell and van Praag (2002), Groot and van den Brink (2004), Powdthaveea and van den Berg (2011), Oswald and Powdthavee (2008) and McNamee and Mendolia (2014) where the equivalent income for specific diseases, disabilities and pains was estimated. The wellbeing valuation method has also been used to monetarize other non-market commodities such as marriage, crime and informal care (see for instance, Clark and Oswald, 2002; Moore and Shepherd, 2006; van den Berg and Ferrer-i-Carbonell, 2007). Typically for this approach, a measure of subjective wellbeing is regressed on income and health conditions along with other socio-economic variables. The trade-offs between income and the health conditions are then estimated so that the income equivalence that is necessary for the individual to achieve the level of wellbeing before health deterioration can be approximated.

To date the wellbeing valuation studies in health have focused on broad categories of disease such as migraine and diabetes (Groot and van den Brink, 2004; Powdthaveea and van den Berg, 2011), which limit its applicability in economic evaluation where the most common outcome is to measure health using generic preference-based measures such as QALYs.

This study advances the wellbeing valuation method and uses general life satisfaction with a generic measure of health, the short form 6-dimensions (SF-6D), to estimate the dollar value of a QALY. Unlike previous wellbeing valuation studies where either a monetary compensation (also termed willingness to accept) was estimated or a general equivalent income was presented without further distinctions on willingness to pay or accept, we explicitly provided an estimate of

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willingness to pay using an instrumental variable approach. Also, by using the SF-6D which is a preference-based health measure that can be used to describe more than 18,000 health states and generate QALYs (Whitehurst et al., 2011), we extended the potential empirical application of the wellbeing valuation method from monetarizing specific illnesses to monetarizing various conditions. Hence, with the estimated willingness to pay, we are attempting to facilitate a net-benefit approach to economic evaluation.

The rest of the paper is organized as follows: Section 2 introduces the conceptual framework. Section 3 describes the empirical method and the data. Section 4 presents the results and examples of how the results can be applied. Section 5 concludes.

2. Conceptual framework

For simplicity, we assume that an individual's wellbeing depends on income y and health h. The individual's wellbeing in period t can be described as

$$W_{it} = W(Y_{it}, H_{it})$$

where Y_{it} is a vector of incomes y_{it} from the past up till the present, hence allowing incomes from the past to affect current wellbeing, for instance via savings or adaptation; H_{it} is a vector of health outcomes h_{it} from the past till the present, allowing past health to affect current outcomes, for instance via effects on social capital or adaptation.

We can define the wellbeing an individual experiences in a T-year interval as

$$W_i(Y_i, H_i) = \sum_{t=0}^{T} W(Y_{it}, H_{it})$$

where T could be a year, a decade, or a whole lifetime and Y_i and H_i now denotes income and health over the whole time-span. Consider then an individual who experiences a change in their health vector ΔH_i in this T-year window. The income change ΔY_i that is equivalent to this health change is now the income change that holds wellbeing constant and thus solves

$$W_i(Y_i, H_i) = W(Y_i + \Delta Y_i, H_i + \Delta H_i) \quad (1)$$

Now, because the equivalence holds for the sum of wellbeing over the T-year window, there are in principle an infinite number of vectors ΔY_i that equalize a health change and thus could constitute a willingness to pay. One important scenario is a lump-sum payment for a particular health improvement over the T-year rolling window, and the payment could be made at either the start or end of the T-year rolling window. We are also interested in the willingness to pay in the current year (or the most recent year of the T-year rolling window) for a sustained health improvement still enjoyed in the current year, which represents the long-run equilibrium payment for a sustained health improvement.

It is important to realize that equation (1) will be measured by using levels of wellbeing experienced, rather than anticipated levels of wellbeing. Hence, we identify the equivalent income that maintains wellbeing therefore measuring the willingness to pay of a ‘rational’ individual.

3. Empirical methods

3.1. Model

In the model to be considered, we use a T-year rolling window (T = 2) of variables

$$LS_{it} = a + b_0 \cdot SF-6D_{it} + b_1 \cdot SF-6D_{it-1} + c_0 \cdot LTC_{it} + c_1 \cdot LTC_{it-1} + d_0 \cdot Y_{it} + d_1 \cdot Y_{it-1} + g \cdot X_{it} + \lambda_i + \delta_t + u_{it} \quad (2)$$

where LS_{it} refers to the life satisfaction for individual i in time t, $SF-6D_{it}$ is the generic health utility score, LTC_{it} is a dummy variable indicating long term health conditions (termed LTC), Y_{it} is the equivalised household income of the individual at time t where equivalised income was obtained by weighting the household income by how many members are in the household with a weight of 1 applied to first adult, 0.5 to an additional adult and 0.3 to each child (Hagenaars et al., 1994); λ_i is an unobserved time invariant individual factor, δ_t is a year fixed effect, and u_{it} is an error term. A conventional vector of other socio-economic variables that could have an impact on life satisfaction is included and represented by X_{it}, which incorporates age, marital status, education, leisure capacity, and unemployment.

Here health is described by the SF-6D and LTC, and willingness to pay approximated by income. We have chosen a rolling window of T = 2 years (t and t-1) to allow for the estimation of a willingness to pay over a relatively short period of time, as well as the capture of adaptation effect of income and health (see Appendix Method S1 for an illustration of the equations for T = 3 [INSERT LINK TO ONLINE FILE A]). With the dynamic specification, the effect of a health utility change is described by $b_0 + b_1$ and the total effect in accumulated health utility over the 2-year window is then $T*b_0 + (T-1)*b_1$. Similarly for the effects of a LTC where the total accumulated effect of a change is $T*c_0 + (T-1)*c_1$.

The dynamic specification also allows us to compare the importance of income and health changes over time: the total effect of a permanent income change is $d_0 + d_1$ per dollar per year and a permanent health change is $b_0 + b_1$ and $c_0 + c_1$.

Therefore, the amount of money that individuals should be willing to give up for a health change given a constant level of ($LS_{it} + LS_{it-1} + LS_{it-2} + ... + LS_{it-T+1}$) can be estimated as follows. The average willingness to pay per year for maximum health utility improvement (hence $\Delta SF\text{-}6D = 1$ or $\Delta QALY = 1$ based on the interval scale property of SF-6D and the annual structure of HILDA) and for not having a long-term health condition ($\Delta LTC = -1$), which we term WTP_S and WTP_L, in the T-year window (T = 2) can be estimated as:

$$WTP_S = ((T*b_0 + (T-1)*b_1)/(T*d_0 + (T-1)*d_1)$$

$$WTP_L = ((T*c_0 + (T-1)*c_1)/(T*d_0 + (T-1)*d_1) \quad (3)$$

In terms of the long-run equilibrium for a sustained health improvement, the willingness to pay is estimated as:

$$LRWTP_S = (b_0 + b_1)/(d_0 + d_1)$$

$$LRWTP_L = (c_0 + c_1)/(d_0 + d_1) \quad (4)$$

3.2. An instrumental variable approach

A major concern of our empirical strategy as described by equation (2) is that, when one controls for time invariant individual traits (fixed effects) which could be correlated with both life satisfaction and income, the estimates are largely influenced by income changes that are prone to high measurement error. Measurement error could arise from income changes that people are unaware of or would not interpret as meaningful, such as changes due to an updated pension policy or inflation. We also have some concern over the asymmetry effect of income on wellbeing, namely that the effect of a loss of one dollar is generally greater than the effect of a gain of one dollar (Tversky and Kahneman, 1991), implying that forcing income to have a single coefficient over loss and gain could bias the estimated willingness to pay upwards.

Owing to the strong likelihood of an endogeneity bias of income due to measurement error, an instrumental variable is required. We use financial worsening event which is available from the HILDA survey as instrument for income as inspired by Mervin and Frijters (2014) and Frijters et al. (2011). Financial worsening event is by definition correlated with income and can be assumed to affect life satisfaction through its negative impact on income. Using financial worsening as instrument ensures that the wellbeing effect of income is measured through the financial changes that people recognize, and that we are not basing our estimates on measurement errors in income. Also, financial worsening resembles expense (or willingness to pay) rather than compensation (or willingness to accept) and thus addresses the problem of an asymmetric effect of income. Our dynamic specification with the instrumental variable strategy, as indicated in Frijters et al. (2011), by-passes the well-known difficulties of correctly estimating the importance of income for life satisfaction (for a summary of these difficulties see Clark et al., 2008).

More specifically, we instrument the two income variables in (2) with FW_{it}, FW_{it-1} and FW_{it-} , where FW_{it} denotes whether an event of financial worsening took place last year, and FW_{it-} whether the financial worsening shock took place in any year > two years ago (which captures the longer-term effect of a financial worsening).

To test the quality of the instruments statistically, we use the Cragg-Donald Wald F statistic and Stock and Yogo critical values (for weak instruments), Anderson canonical correlations likelihood-ratio test (for under identification), Hansen-Sargan test (for over identification), and an endogeneity test of the endogenous variables.

3.3. Data

For the empirical analysis, we use the Household, Income and Labour Dynamics in Australia (HILDA) survey, which is a longitudinal household panel that is nationally representative with the exception of under-sampling people living in remote and sparsely populated areas. Beginning in 2001, HILDA contains over 10,000 individuals who are at least 15 years of age at the time of the interview from more than 7000 households. We use all waves where our variables of interest including financial worsening are available (waves 2 to 15), covering 14 years of data from 2002 to 2015. HILDA Survey is funded by the Department of Social Services (Australia) and is managed by the Melbourne Institute, and was approved by the Human Research Ethics Committee at the University of Melbourne (1647030). Appropriate approval was obtained for this study from the Department of Social Services to access the publicly available, de-identified longitudinal dataset.

Life satisfaction is assessed using the response to the question “All things considered, how satisfied are you with your life?”, scored as ‘10’ if they are totally satisfied, and ‘0’ if totally dissatisfied. The distribution of the responses to this question are negatively skewed, with approximately 70% of the responses scored as 8 and above. The SF-6D scores in HILDA are derived from the short form 36 (SF-36) (Summerfield et al., 2016). SF-6D is composed of six multi-level dimensions including physical functioning, role limitations, social functioning, pain, mental health and vitality. It has interval scale property and is anchored at 1 for full health and 0 for dead (Brazier et al., 2002), although the ranges of index values are on a 0.301 to 1. The distribution of the SF-6D scores from HILDA is negatively skewed with the median scores being 0.795. The distributions of life satisfaction and the SF-6D scores are illustrated in the Appendix (Figure S1 [INSERT LINK TO ONLINE FILE B]).

HILDA also identified people with long-term health conditions using the question “Looking at showcard K1, do you have any long-term health condition, impairment or disability (such as these) that restricts you in your everyday activities, and has lasted or is likely to last, for 6 months or more?”. 27% of the person-year responses are “Yes” across all 14 waves. Responses for financial worsening events are elicited using the following question: “Did any of these happen to you in the past 12 months? Major worsening in financial situation (e.g., went bankrupt)”. 3% of the person-year responses are “Yes”, which represents 13% of the respondents who in some year have had a major worsening. Put differently, although on average only 3% of people have a financial worsening in each wave, across waves financial worsening happens to 13% of the population at least once. We checked whether these respondents looked very different since their financial shocks drive the main results. Their mean age, gender, marriage rate, education and leisure capacity were all within 5% of those who never had a financial worsening.

After excluding 140 observations with life satisfaction response missing, our sample consists of 203,808 person-year responses corresponding to 28,347 individuals. The key characteristics of the sample are summarised in Table 1.

Table 1
Key characteristics of the sample at person-year response level.

	Mean	SD	Measure
Life satisfaction	7.9	1.5	0-10, 0 totally dissatisfied, 10 totally satisfied
Equivalised household income[a](A$1000)	50.872	42.494	−2452.200–1021.406
SF-6D	0.761	0.123	0.301–1
Long-term conditions	0.274	0.446	0 no, 1 yes
Financial worsening	0.031[b]	0.173	0 no, 1 yes
Age	44.3	18.7	15–101
Married/de facto	0.619	0.486	0 no, 1 yes
Education	2.0	0.8	0-3, 1 less than Year 12, 2 Year 12 or equivalent, 3 bachelor or above
Leisure capacity[c]	0.362	0.458	0 no, 1 yes
Unemployment	0.038	0.191	0 no, 1 yes

[a] All incomes are converted to 2015 Australian dollar price. Negative equivalised household incomes are included to allow the full impact of financial worsening to be demonstrated. A negative response could arise when households incur losses in their unincorporated business or have negative returns from their other investments (Australian Bureau of Statistics, 2015).

[b] At individual level, 13% of the individuals have reported financial worsening events in one or more waves.

[c] Leisure capacity is approximated using the percentage of time not in paid employment in the last financial year.

4. Results

4.1. Base case results

The fixed effect model results with and without IV are reported in Table 2. For the model with IV, a Cragg-Donald F value of 17.25 rejects the null that our instruments are weak. The Anderson test suggests that

Table 2
Estimated effects on life satisfaction.

	Fixed effect, no IV		Fixed effect, with IV	
Income in 1000's	0.0006**	(0.0001)	0.080**	(0.010)
Income in 1000's, a year ago	0.0004**	(0.0001)	−0.035**	(0.010)
SF-6D	2.432**	(0.037)	2.258**	(0.134)
SF-6D, a year ago	0.749**	(0.037)	0.778**	(0.136)
Long-term condition	−0.089**	(0.009)	−0.153**	(0.034)
Long-term condition, a year ago	−0.005	(0.009)	0.057	(0.034)
Age	−0.025	(0.015)	0.001	(0.056)
Age squared	0.0004**	(0.000)	0.001**	(0.000)
Married/ de facto	0.296**	(0.013)	−0.012	(0.066)
Education	−0.086**	(0.014)	−0.099	(0.054)
Leisure capacity	0.042**	(0.012)	0.734**	(0.102)
Unemployment	−0.170**	(0.019)	−0.225**	(0.068)
No. of observations	134,224		106,457	
Test statistics				
Cragg-Donald			17.25	
(Stock and Yogo 10% maximal IV size critical value: 13.43)				
Anderson (χ^2)			51.72	
Sargan (χ^2)			0.16	
Endogeneity[a] (χ^2)			588.99	

*0.05 **0.001. Standard errors in parentheses. Year-dummy coefficients are omitted.

[a] Difference of two Sargan-Hansen statistics.

the equation is identified, and the Sargan statistic cannot reject the null that the instruments are valid. The endogeneity test rejects the null that income can be treated as exogenous. Overall, the test statistics suggest that an instrument for income is needed in the fixed effects model and that the choice of financial worsening is appropriate. The first stage results of the model with IV are reported in the Appendix (Table S1 [INSERT LINK TO ONLINE FILE C]), confirming that financial worsening and income have a statistically significant correlation thus our instrument is not weak. The first stage results also show that the effect of an average financial worsening relates to an accumulated income loss of approximately A$23,000 over a 2-year period.

As shown in Table 2, income is estimated to have a statistically significant impact on life satisfaction for both fixed effect models, however the effect of income is much larger in the model with IV indicating that endogeneity of income and measurement error are addressed. The magnitudes of the income coefficients with IV (Table 2) indicate that on average, a one-off income loss of A$10,000 lowers life satisfaction by about 0.5 unit on the scale over a 2-year rolling window, with life satisfaction drops by 0.8 in the first year and bounds back by 0.3 in the second year. A sustained decrease in equivalised disposable income of A$10,000 lowers life satisfaction by about 1.25 unit on the scale over 2 years, with life satisfaction drops by 0.8 in the first year and drops a further 0.45 in the second year.

The wellbeing impact of health, as represented by SF-6D and long-term condition status, are also statistically significant except for the long-term condition status 'a year ago', confirming that individual's life satisfaction rises as health improves and falls when it declines. The magnitudes of the health utility coefficients with IV (Table 2) indicate that on average, a 0.2 sustained increase in health utility raises life satisfaction by about one unit on the scale holding all other factors constant.

Using formulas (3) and (4) in Section 3.1, it is estimated that the average willingness to pay for one QALY is approximately A$42,000 over a 2-year rolling window, and A$67,000 in the long run for a sustained health improvement (Table 3, base case). The long-run willingness to pay for a sustained health improvement is estimated to be larger as individuals adapt to a sustained change in income (exemplified by the negative coefficient on lagged income) whilst we see the opposite for SF-6D (the effect of lagged SF-6D is positive indicating that the effect accumulates). In other words, people discount money differently from health. The willingness to pay per year for not having a long-term condition is estimated to be around A$2000 holding health-related quality of life constant. This suggests that having a long-term condition penalises life satisfaction even if the condition has similar impacts on quality of life as a temporary condition. Perhaps this is due to the inconvenience and worry associated with a long-term condition, or that people think the conditions will get worse the longer they last.

4.2. Robustness tests

To test the robustness of the results, a number of alternative specifications are examined. We first check the impact of using different data periods on the estimated willingness to pay, the impact of limiting data to wave 2–13 (older data) and then wave 4–15 (more contemporary data) respectively. We then use personal disposable income instead of equivalised household income, controlling for the number of adults and children in the household. Next we examine the cases when negative equivalised household income are dropped and when logarithm transformation of income is used (willingness to pay per QALY is reported at the median level of income for the logarithm transformation). We also calculate the willingness to pay for gender subgroups and for people aged 30 and above (dropping those who are very young thus less likely to have health concerns). The results are summarised in Table 3.

As shown in Table 3, when more contemporary data (wave 4–15) are used willingness to pay estimates are slightly higher compared with when older data (wave 2–13) are used, although both results are very close to the base case, indicating that our method has the potential to be used to update QALY thresholds as time passes by. When personal disposable income instead of equivalised household income is used, willingness to pay is estimated to be slightly lower and still close to the base case. When only positive income and logarithm of income are

Table 3
Base case results and robustness tests.[a]

	Base case (fixed effect with IV, wave 2–15)	Older data (wave 2–13)	Newer data (wave 4–15)	Personal income	Personal income (number of persons controlled for)	Positive income only	Log income	Subgroups		
								Men	Women	Age > 30
Estimated coefficients										
Income in 1000's	0.08**	0.08**	0.08**	0.09**	0.09**	0.09**	4.96**	0.07**	0.08**	0.07**
Income in 1000's, a year ago	−0.03**	−0.03*	−0.04**	−0.04*	−0.04*	−0.04**	−1.68**	−0.04*	−0.03	−0.03*
SF-6D	2.26**	2.22**	2.23**	2.48**	2.48**	2.22**	2.23**	2.16**	2.42**	2.24**
SF-6D, a year ago	0.78**	0.74**	0.80**	0.87**	0.87**	0.77**	0.55**	1.05**	0.57**	0.80**
Long-term condition	−0.15**	−0.16**	−0.16**	−0.17**	−0.17**	−0.16**	−0.13**	−0.20**	−0.10*	−0.13**
Long-term condition, a year ago	0.06	0.05	0.05	0.07	0.08	0.05	0.07*	0.09	0.02	0.06
Willingness to pay (A$)										
2-year rolling window										
1 QALY	42,250	41,976	45,602	41,021	41,044	39,066	35,954	53,516	38,185	45,718
Long-term condition premium	1985	2160	2332	1832	1815	2005	1021	2978	1347	1859
Long-run equivalence										
1 QALY	67,022	62,763	75,619	64,974	65,088	66,099	57,242	102,038	51,805	71,696
Long-term condition premium	2113	2317	2716	1803	1767	2373	833	3305	1503	1883

[a] Statistical tests as specified previously suggest that the instruments are valid in all alternative scenarios presented and reject that the instruments are weak at 10% or 15% Stock and Yogo maximal IV size except for the subgroup of women where the null that the instruments are weak is rejected at 20% maximal IV size. *0.05 **0.001.

used, willingness to pay estimates are visibly smaller as observations with financial worsening events that reduce income to negative are excluded, causing the income impact of financial worsening to be limited.

We also found some heterogeneity in the willingness to pay across sub-populations. More specifically, our results suggest that men on average are likely to be willing to pay more for health compared to women, mainly owning to a larger overall impact of health relative to income and a slower adaptation to health changes. When limiting the sample to people aged 30 and above, average willingness to pay for a QALY is estimated to be larger, due to that health utility appears to have a relatively bigger impact on life satisfaction compared to income when younger people were dropped. These results suggest that population characteristics matter to the estimated willingness to pay due to the difference in the perceived wellbeing value of health and income.

One worry would be that financial worsening is related to other negative shocks such as relationship strain or losing a job, and that it would thus capture more negative effects than merely the loss of income. To this end, we ran additional specifications including indicators of whether someone was fired the last year or separated from their partner. Adding these in as controls made no difference larger than 5% to the estimated willingness to pay. We have also tested the setting when T = 3. It appears that further lags for income and health were neither statistically or economically significant. Also, due to the limited impact of financial worsening further back, instrumental variable was rendered weak.

Finally, there is the issue of measurement error and reverse causality in the SF-6D. Measurement error in the case of the SF-6D, which is derived from 11 items of the SF-36, is likely to be less of a concern than with single-item questions. Nevertheless, we ran regressions with random effects rather than fixed effects, in which case the health coefficients also include the effects of the variation across individuals, which reduces reliance on changes in health and thus reduces any importance of measurement error. We find only modest changes in the coefficient of the SF-6D, indicating that measurement error is likely to be small in our dataset relative to true changes in health.

4.3. Applications

To demonstrate how the willingness to pay estimates could be applied, we use three studies from the literature and estimate the dollar equivalent values of the temporary and long-term health conditions or disease prevention. The base case estimates are applied in all the examples. These are intended to provide illustrative examples of how our estimates can be used in practice.

First, we use the study by Bilcke et al.(2014) in which the QALY impact of influenza-like-illness and flu was estimated using the SF-6D. We apply the willingness to pay per QALY estimate over a short rolling window to assess the dollar equivalence of this temporary condition, treating the condition and consequently the willingness to pay as a one-off. Next, as an example of a long-term condition, we use the work by Eriksson et al. (2010) where the QALY effect of lifestyle interventions in reducing cardiovascular risk was examined. We applied the long-run equivalent willingness to pay per QALY for this intervention. The willingness to pay in this case did not include the additional willingness to pay for not having a long-term health condition as it is unknown from the study as to what degree cardiovascular risk is reduced. Lastly, we use the research by Sun et al. (2010) where the substitution of whole grains for white rice in relation to risk of type 2 diabetes was studied. The study showed that replacing intake of white rice with whole grains was associated with a 36% lower diabetes risk (the QALY difference was not available). We estimate the willingness to pay for this risk reduction using the estimated reduction in cardiovascular risk (36%) times the willingness to pay for not having a long-term health condition. The results are presented in Table 4.

As shown in Table 4, individual's average willingness to pay for not having an influenza-like-illness or a clinically diagnosed flu is estimated to be around A$211. For people with high cardiovascular risk, a certain life style intervention that could improve health-related quality of life is estimated to be worth an average payment of A$894 per year. To lower diabetes risk, it would be worthwhile to pay A$761 per year to replace intake of white rice with whole grains.

If the costs of these health conditions and interventions are provided, our willingness to pay estimates can either be used to inform a threshold for cost-effectiveness analysis, or to facilitate a net-benefits approach.

5. Conclusions and discussions

Using subjective wellbeing as experienced utility, we estimate the willingness to pay for health using equivalised disposable income instrumented by financial worsening events, where health is described by SF-6D and long-term condition status. The estimates have the potential to facilitate the evaluation of a variety of health programmes as demonstrated in Section 4.3. As this method relies on questions on life satisfaction, household income, financial events and a generic health status instrument which can be more easily obtained from or incorporated into existing large population-representative survey such as the British Household Panel Survey (BHPS) as compared with methods based on hypothetical and scenario-specific questions, the approach has the potential to be replicated internationally and guide the country-specific QALY values.

Despite the methodological and the conceptual differences, the yielded estimates from our approach (A$42,000-A$67,000 per QALY) are not dissimilar to the observed QALYs thresholds in decision marking in Australia (George et al., 2001). However, it is worth highlighting that our results indicate a further willingness to pay for not having a long-term condition holding health-related quality of life constant, which could be an argument for a higher threshold for long-term conditions. Also, we derive the willingness to pay per QALY based on individual utility maximization and interpret it as individual's average willingness to pay. From a societal perspective, the value of health could be higher given that some health cost such as sick leave due to a flu are primarily costs to business not individuals. Given that the method measures willingness to pay using individual preferences, our approach also does not consider the health system level trade-offs, which has recently been explored in Claxton et al. (2015). Such issues will need to be considered if the estimates are adopted as basis for health care decision making.

Interestingly, the estimated willingness to pay per QALY (A$42,000) is less than the willingness to pay per wellbeing (a change from 3 to 10 on a life satisfaction scale based on Appendix Figure S1 [INSERT LINK TO ONLINE FILE B]) which is estimated to be approximately A$112,000 per year over a 2-year rolling window, indicating that full wellbeing is perceived to be worth more than just a year of life with perfect health, or put differently that other life circumstances also contribute significantly to wellbeing and their impacts cannot be substituted by perfect health.

A limitation of our method is that willingness to pay for health could be underestimated owning to the adaptation effect, namely that people with long-term conditions can revise the rating of subjective wellbeing after adapting to the situation despite health not improving. An extreme example of the adaptation effect would be that people who become blind in adulthood gradually have learnt to appreciate other pleasures of life, and their life satisfaction could rise even when blindness goes on (Ubel et al., 2000). However, this does not mean that these people are not willing to pay large amount of money for eyesight treatment and outcomes. The estimated willingness to pay needs to be treated with care in such cases (for a more detailed discussion of the issue of adaptation effect, see Oswald and Powdthavee, 2008; and Loewenstein and Ubel, 2008). We should also contemplate whether using life satisfaction to measure the value of health could distort people's intention to report truthfully–an old concern for many other survey-based

Table 4
Estimated willingness to pay for health.

Example	Participant characteristics	QALY impact/ long-term condition risk	Willingness to pay
Influenza-like-illness and clinically diagnosed flu (Bilcke et al., 2014)	A general population sample who experienced 5–6 symptoms over a 6-day period with an average episode amounted to 4 days of absence from work or school.	Loss of 0.005 QALY	A$211
Life style intervention in reducing cardiovascular risk (Eriksson et al., 2010)	People aged 18–65 years, with hypertension, dyslipidaemia, type 2 diabetes mellitus, obesity, or any combination thereof.	Gain of 0.04 QALY over 3 years	A$894 per year
Substitution of whole grains for white rice to lower risk of type 2 diabetes (Sun et al., 2010)	People aged 26 to 87 with no diagnoses of diabetes, cardiovascular disease, or cancer at baseline.	A 36% lower diabetes risk	A$761 per year

methods.

Also, we interpreted people's willingness to pay for health as pay for a health gain or pay to reverse a health loss, as those who had a health improvement would have a health loss first given that the SF-6D is bounded by 1. In this sense, we have implicitly assumed that the impact of a health loss and a health gain on life satisfaction are similar, and a health gain can bring life satisfaction back to the level prior to when the health loss occurred, holding all else constant. This could be another limitation of the study. We also note here that although experienced wellbeing (life satisfaction) was used, the QALYs in this study were generated using the SF-6D scores which were based on the currently widely accepted stated preference weights. Whether QALYs should be generated using other methods is beyond the scope of this study.

As this is the first study that uses the wellbeing valuation method to monetise the value of a QALY, we believe that future research that replicates the method across other common health utility instruments such as EuroQol five dimensions (EQ-5D) will be valuable. It is also of great interest to explore how the results compare across datasets and countries, as willingness to pay for a QALY in various countries are most likely to be different depending on people's perceptions of the value of health and other life factors as well as income levels.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.socscimed.2018.06.009.

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