The Subjective Well-Being Method of Valuation: An Application to General Health Status

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Objective. To introduce the subjective well-being (SWB) method of valuation and provide an example by valuing health status. The SWB method allows monetary valuations to be performed in the absence of market relationships.

Data Sources. Data are from the 1975–2010 General Social Survey.

Study Design. The value of health status is determined via the estimation of an implicit derivative based on a happiness equation. Two-stage least-squares was used to estimate happiness as a function of poor-to-fair health status, annual household income adjusted for household size, age, sex, race, marital status, education, year, and season. Poor-to-fair health status and annual household income are instrumented using a proxy for intelligence, a temporal version of the classic distance instrument, and the average health status of individuals who are demographically similar but geographically separated. Instrument validity is evaluated.

Principal Findings. Moving from good/excellent health to poor/fair health (1 year of lower health status) is equivalent to the loss of \$41,654 of equivalized household income (2010 constant dollars) per annum, which is larger than median equivalized household income.

Conclusion. The SWB method may be useful in making monetary valuations where fundamental market relationships are not present.

Key Words. Subjective well-being, valuation, happiness, health status

A growing literature, largely untapped by health services researchers, suggests that an alternative technique for valuing nonmarket goods and services, the subjective well-being (SWB) valuation method, may offer large advantages over more traditional approaches to valuation (Dolan 2008a; Dolan and Kahneman 2008; Dolan and Peasgood 2008). What are the benefits of valuing nonmarket goods and services (e.g., mental health, public health, etc.)? Many aspects of health and health care do not have market values, yet policy makers must make decisions about them nonetheless. To make these

decisions in a more rational fashion, policy makers must have access to information on costs and benefits whether or not market valuations of costs and benefits are available.

Economists have developed techniques to determine valuations for non-market good/services, including the revealed preference approach (which depends on the presence of at least indirect market relationships), the contingent valuation/stated preference approach (which relies on individuals' estimates regarding how they would make hypothetical trade-offs), and the SWB valuation approach (which measures actual, but implicit, trade-offs). This paper presents a short discussion of the revealed preference and contingent valuation approaches and then focuses on an explanation of the SWB valuation method including an extended example where the ubiquitous health measure, self-rated health status (SRHS), is valued.

Self-rated health status is a valid and reliable measure of general health status (DeSalvo et al. 2006a). It predicts cardiovascular events, disability, and mortality (Idler, Russell, and Davis 2000; DeSalvo et al. 2006b; Rutledge et al. 2010; Pietiläinen et al. 2011). It mirrors changes in health related to various types of illness (e.g., epilepsy, diabetes, cancer) and reflects participation in health risk behaviors (Manderbacka, Lundberg, and Martikainen 1999; Manor, Matthews, and Power 2001; Nakata et al. 2009; Prosper, Moczulski, and Qureshi 2009).

We conclude the paper by listing selected datasets that can be used to implement the SWB valuation method.

The Subjective Well-Being Valuation Method

The revealed-preference method has a long history of use in valuing the most basic goal of health care: life. There is a large literature using the revealed-preference method to estimate the value of a statistical life (VSL) that is the basis for the VSL used by the federal government (U.S. Office of Management and Budget 2003; Silny, Little, and Remer 2010; Viscusi 2011). A commonly used approach is to estimate the trade-off that individuals implicitly make between the higher risk of mortality that accompanies certain jobs and the increased wages that these jobs pay (Bellavance, Dionne, and Lebeau 2009). However, this approach requires that a set of fundamental market relation-

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ships exist with regard to what is being valued. These relationships are often absent for many health-related measures of interest, suggesting that an alternative approach is necessary.

One alternative approach that does not depend on the existence of market relationships is the contingent valuation method (CVM), which assigns values to health states by one or both of two theoretically equivalent approaches: (1) determining the minimum amount of money a person would be willing to accept (WTA) for a given health state or (2) determining the maximum amount of money a person would be willing to pay (WTP) to forgo a given health state (Koopmanschap et al. 2008; Oremus and Tarride 2008). In both approaches, the accuracy of CVM depends on individuals accurately imagining their experience of various health states over time.

The most direct way to determine WTP/WTA is through an open-ended question asking how much a person would pay/accept for a given health outcome. Another method is to present a single monetary value for a person to accept/reject (Oremus and Tarride 2008). In both cases, the CVM requires that individuals perform mentally demanding tasks that are rarely-to-never encountered in real-life situations. In addition, only the factors that a respondent is actually aware of will be included in the valuation.

There are at least two reasons to suggest that these imaginings may bias valuations (Dolan 2008b; Dolan et al. 2008). Both are “focusing effects.” First, valuations are likely impacted by the “peak start rule” that describes the tendency of survey respondents to focus on the worst impacts of a health change: those that tend to be experienced at the start of a change in health status. Second, in answering WTP/WTA questions, survey respondents are primarily focusing on the health domain of life as opposed to other domains of life. While it may seem that these problems could be solved by querying actual patients, similar focusing problems occur in that context also (Smith et al. 2006, 2008).

Dolan et al. (2008) note that the WTA valuations are typically two-to-eight times larger than WTP valuations (Knetsch and Sinden 1984; Brookshire and Coursey 1987; Coursey, Hovis, and Schulze 1987; DuBourg, Jones-Lee, and Loomes 1997; Horowitz and McConnell 2002). It has been found that factors related to study design and the techniques used in eliciting answers from respondents contribute to these differences, including explicit statement of the price, iterative bidding, within/between-subjects nature of the design, and out-of-pocket payments. Meta-analytic findings suggest that iterative bidding and within-subjects designs decrease the WTP/WTA disparity, whereas out-of-pocket payments increase the disparity as compared to tax reductions and other indirect payments (Sayman and Onculer 2005).

Another alternative approach, and the subject of this paper, is the SWB valuation method. There are at least three fundamental concepts of quality of life (Sirgy 2012). The first is eudaimonic well-being, relating to meaning and purpose. The second is hedonic well-being, the affective component of SWB. The third is life satisfaction, the cognitive component of SWB, relating to evaluation against some standard. The SWB valuation method focuses on the latter two concepts, concepts that share a maximum of 50–60 percent common variance (Sirgy 2012).

The SWB valuation method has been widely applied to value goods and services for which no market exists (Di Tella and MaCulloch 2006). It has been used to determine the value of noise, air pollution, climate, floods, droughts, and proximity to waste facilities, coastlines, and transportation routes (Welsch 2002, 2006; van Praag and Baarsma 2005; Brereton, Clinch, and Ferreira 2008; Carroll, Frijters, and Shields 2009; Luechinger 2009; Luechinger and Raschky 2009; MacKerron and Mourato 2009). It has been used to value crime, fear of crime, corruption, civil conflict, and terrorism (Moore 2006; Cohen 2008; Frey, Luechinger, and Stutzer 2008; Welsch 2008a,b). Of most interest to health services researchers is that the SWB valuation method has also been used to determine the value of specific types of illness, mental health, publicly provided health care, and informal care (Ferrer-I-Carbonell and van Praag 2002; van den Berg and Ferrer-I-Carbonell 2007; Kotakorpi and Laamanen 2010; Powdthavee and van den Berg 2011; Fujiwara and Dolan, 2014).

To value SRHS, the SWB approach implicitly asks: “Considering your overall happiness at a particular level of SRHS, how much money must we pay you to make you just as happy if we reduced your SRHS to a particular lower level?” Yet the SWB method never requires respondents to actually deal with this cognitively difficult question. The SWB method does not ask respondents to make any hypothetical trade-offs; and it can capture factors that relate to value whether a respondent is aware of how they relate to happiness.

The SWB procedure is to estimate a happiness equation. When both SRHS and household income are included, it is possible to determine the monetary amount that could be exchanged for levels of SRHS such that the average individual would be just as well off in terms of happiness. Given the following happiness function:

$$hp = u(h, y, z) \quad (1)$$

where hp is happiness, h is SRHS, y is household income, and z is a set of control variables. The marginal rate of substitution (MRS), indicating the amount

of money required to compensate an individual for a given loss of health, is then given by implicit derivative:

$$\partial y / \partial h = - [(\partial hp / \partial h) / (\partial hp / \partial y)] \quad (2)$$

When using the SWB method, at least three measurement issues arise. First, measures of happiness must be valid and reliable. Happiness measures have been evaluated and appear to be meaningful and amenable to statistical analysis. Frey and Stutzer's (2002) overview of happiness research notes that different measures of happiness correlate well, self and nonself reports of happiness share a single underlying construct as shown by factor analysis, happiness measures are fairly stable yet sensitive to changes in life circumstances, and people reporting higher levels of happiness smile more often and are less likely to commit suicide (Fordyce 1988; Headey and Wearing 1991; Sandvik, Diener, and Seidlitz 1993; Fernandez-Dols and Ruiz-Belda 1995; Ehrhardt, Saris, and Veenhoven 2000; Koivumaa-Honkanen et al. 2001). See Krueger and Schkade (2008) for a discussion of the reliability of SWB measures.

Second, most happiness scales are ordinal. While this is sufficient, as the MRS is an ordinal concept, it has been found that assuming such measures are cardinal makes little difference in empirical results that compare ordered logit/probit models with ordinary least-squares models (OLS) (Ferrer-I-Carbonell and Frijters 2004). This finding has been repeated by van den Berg and Ferrer-I-Carbonell (2007), Brereton, Clinch, and Ferreira (2008), Frey, Luechinger, and Stutzer (2008), Oswald and Powdthavee (2007), Luechinger and Raschky (2009), MacKerron and Mourato (2009), Levinson (2012), and others. Many studies only use OLS (e.g., Moore 2006; Luechinger 2009; Powdthavee 2009). Other studies standardize the happiness measure in a way very similar to a *z*-score: "probit-adapted OLS" (van Praag and Ferrer-I-Carbonell 2008). This method transforms the value of each categorical answer into the expected value of a standard normal variable, conditional on being between the estimated upper and lower cutoff points as established from an ordered probit model estimated using only the ordered happiness indicator, in effect "cardinalizing" the ordinal variable (Cornelissen 2009). This approach yields substantially the same results as ordered probit but allows the coefficients of the statistical model to have a meaningful interpretation: standard deviations of happiness (van Praag and Ferrer-I-Carbonell 2008).

Third, the adaptive nature of human happiness must be accounted for. Psychologists have noted that individuals adapt to new situations/goods over time such that the additional happiness they experience starts out high and then attenuates. Economists have examined this, and a recent study found that

only 42 percent of the increase in happiness experienced 1 year after an increase in income still remained after 4 years (Di Tella, Haisken-DeNew, and MacCulloch 2010). Frijters, Johnston, and Shields (2011) have shown that adaption varies with the type of life change a person experiences, with adaption-to-income changes following a different pattern than adaptation to serious health challenges.

All of the above issues must all be accounted for to validly ascertain the value of SRHS using the SWB technique. How this may be done can be demonstrated using a widely used dataset.

METHODS

Data

Data come from the 1972–2010 General Social Survey (GSS) making up 28 waves of repeated, nationally representative cross-sections. The GSS was not administered every year and some variables were not always available thus 1972, 1973, 1978, 1983, and 1986 are omitted. The GSS is an in-person survey of adults, with a small proportion of individuals participating by phone. While all races/ethnicities are represented each year, a black oversample (1982, 1987) and the Spanish language sample are not included here.

Statistical Methods

A number of issues must be addressed to obtain consistent estimates of the impact of income and SRHS on happiness. Without accounting for current relative income, past absolute income, wealth, and the effects of reverse causation from happiness to income, estimates of the relationship between current absolute income and happiness will be biased (Graham, Eggers, and Sukhtankar 2004; Smith et al. 2005; Clark, Frijters, and Shields 2008). Reverse causation may occur in the situation where individuals who are happier are able to earn more income (e.g., they are more pleasant to be around, making work groups more productive, which may make happy individuals more likely to be promoted; their good attitude creates good will, which may make them more successful salespeople, etc.). Similar issues also exist with respect to SRHS and happiness (Crossley and Kennedy 2002; Veenhoven 2007; Frijters, Johnston, and Shields 2011; Carrieri 2012). For these reasons and to correct for the effects of unobserved heterogeneity (e.g., omitted variable bias arising from the omission of mental health status and personality type), the

instrumental variable method is used to correct likely bias in the estimated parameters measuring the relationship between happiness and each variable of interest: SRHS and equivalized annual household income. The parameter biases associated with each type of endogeneity (measurement error, omitted variable bias, and reverse causation) are caused by different types of correlations between the variable of interest and the error term. The instrumental variable approach removes these correlations, correcting parameter bias and allowing isolation of the unidirectional causal effects of income and SRHS on happiness (Wooldridge 2005).

Subjective well-being is measured using the question: “Taken all together, how would you say things are these days—would you say that you are very happy, pretty happy, or not too happy?” The answer “not too happy” is coded one, “pretty happy” is coded two, and “very happy” is coded three (Smith 1979). Short scales such as this have been found to reveal only 80–90 percent of the total variance in happiness, while scales with at least seven choices capture 100 percent of the variance (Andrews and Withy 1976). The implication is that the happiness indicator will be measured with random error. As happiness is the dependent variable in the model, this will not bias the estimated parameters, but may increase their standard errors. To make the results of this study easier to understand, the happiness measure is transformed to standard deviations of happiness using probit-adapted OLS (van Praag and Ferrer-I-Carbonell 2008).

Health status is measured using the question, “Would you say your own health, in general, is excellent, good, fair, or poor?” Health is analyzed as a dichotomous measure following the general practice of many studies (e.g., Sundquist and Johansson 1997; McGee et al., 1999; Mansson and Rastam, 2001; Brown, Martinez-Gutierrez, and Navab 2014). In this study, a health status of fair or lower is coded zero and any health status of good or higher is coded one. This is similar to coding poor, fair, or good as zero, and very good or excellent as one when using a five-level health status measure (excellent, very good, good, fair, or poor).¹

The analytic specification is as follows where equations (3) through (5) are estimated using two-stage least-squares (2SLS) (Wooldridge 2005):

$$HP_i = \beta_0 + \beta_1 PF_i + \beta_2 \ln Y_i + \beta_3 D_i + \beta_4 T + \varepsilon_i \quad (3)$$

$$PF_i = \delta_0 + \delta_1 IV + \delta_2 D_i + \delta_3 T + \mu_i \quad (4)$$

$$\ln Y_i = \gamma_0 + \gamma_1 IV + \gamma_2 D_i + \gamma_3 T + v_i \quad (5)$$

where HP_i is happiness in standard deviations. Poor-to-fair health status is PF_i . The variable $\ln Y_i$ is the natural logarithm of equivalized income in 2010 constant dollars: annual household income adjusted for household size using the OECD-modified scale (Ligon 1989; Hagenaars, de Vos, and Zaidi 1994). The standard transformation to natural logarithms is done to account for the diminishing marginal effect of income on happiness (Clark, Frijters, and Shields 2008). Approximately, 5 percent of GSS respondents refuse to provide family income (Hout, 2004). The 2004 GSS methodological report on income specifically expresses doubt that “hot-deck” imputation methods are appropriate for the GSS, given its relatively small annual sample sizes (Hout, 2004). Thus, missing income data were omitted.

The vector, D_i , contains demographic information including sex (male, female), age (18–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75 or older), race (white, black, other race), marital status (single, married, divorced, separated, widowed), and education (less than elementary, elementary, junior high, high school, associate degree, baccalaureate degree, graduate school). The vector T contains year indicators and seasonal indicators (winter, spring, summer, fall). The reference group is male, with good-to-excellent health status, aged 18–24, white, single, with less than an elementary education, zero equivalized income, and was interviewed in the winter of 2010. A negative sign is expected for β_1 (as the reference category is good-to-excellent health). A positive sign is expected for β_2 . The 2SLS results are compared to OLS results.

Three categories of instruments are included in the vector IV to obtain consistent estimates of β_1 and β_2 . The first is a proxy measure of intelligence. Intelligence measures have been repeatedly shown to positively correlate with both health and income, but to not correlate with happiness. A number of studies find intelligence positively correlates with health status independent of schooling (Hartog and Oosterbeek 1998; Auld and Sidhu 2005; Elias 2005). In addition, intelligence measures also positively correlate with income above and beyond educational level (Blackburn and Neumark 1995; Bronars and Ottinger 2006). However, a recent review of 23 individual-level studies found that intelligence measures do not correlate with happiness (Veenhoven and Choi 2012). The proxy measure for intelligence used here is a three-level variable that measures the interviewer’s appraisal of each respondent’s apparent understanding of the interview questions where the possible appraisals are poor, fair, or good, and are assigned the numbers one, two, and three, respectively. While this instrument is an imperfect and impressionistic proxy for intelligence, the presence of some amount of random or systematic measure-

ment error will not invalidate the instrument as long as it satisfies the two standard criteria discussed below.

The second set of instruments represents a temporal variation in the classic distance instrumental variable (McClellan, McNeil, and Newhouse 1994). The GSS contains the exact date a respondent was surveyed, making it possible to calculate the temporal distance between the date a respondent was asked about household income and the date when the respondent is most likely to have accurate information on their income, April 15, the annual filing date for federal and state income tax. On April 15, most respondents will have accurate knowledge of their household income from the previous tax year, which runs from January to December. As income questions in the GSS ask about the previous year's income, two types of temporal distance occur. The first occurs when the date a respondent is asked about household income falls after December 31 (the end of the previous tax year) and before April 15. This is the period during which most respondents will file their income tax returns. The closer the survey date is to April 15, the more likely it is that a respondent will have filed his or her income tax return. Approximately 18.7 percent of respondents were surveyed prior to April 15. This measure (counting up from 0 to 104) was found to have no correlation with either equivalized income or health status in equations (4) or (5).

The second type of temporal distance occurs from April 15 up to December 31, which is the period during which 81.3 percent of respondents were surveyed. This variable is coded 0 up to April 14 and then counts from 1 (April 15th) to 261 (December 31st). As the temporal distance past April 15 increases, individuals will tend to forget the precise level of household income determined on April 15 and will likely round this figure up, with rounding errors increasing the longer the time that has passed after April 15 and before December 31. This will tend to generate a small positive correlation between reported household income and the number of days after April 15 up to December 31 as of the survey. In other words, the further past April 15 that the respondent was surveyed, the more likely the respondent is to report a slightly larger income, other things being equal.

However, the day a respondent is surveyed may also affect their level of happiness due to factors that correlate with season. To condition out this potential effect, season-fixed effects (spring, summer, fall, winter) are included as part of the vector T in equations (3–5).

A final set of instruments is the average SRHS computed for matching gender/age/education cells. Although a person's happiness is impacted by the health of other individuals that are relationally close (Powdthavee 2009) or

geographically close (Carrieri 2012), it is not the case that the health of those who are merely sociodemographically similar but are not geographically or relationally close has any impact on a person's happiness. This is illustrated by estimating Carrieri's (2012) econometric specification in the GSS context, a context where the relative health of individuals in the same gender/age/education cells is virtually certain to be unknown to the individuals surveyed (sample sizes are quite small in each state). In this context, no statistically significant associations are found between average SRHS and happiness or between relative SRHS and happiness.²

As such, although the SRHS of individuals who are similar to the respondent in terms of gender/age/education will positively correlate with the SRHS of the respondent, the average SRHS of this group, made up of individuals unknown to the respondent, is exogenous to the happiness of the respondent. This allows the use of the average SRHS of individuals (matched by gender/age/education) as a valid exogenous instrument.

The above vector of instrumental variables (IVs) must meet the two standard criteria for validity: the instruments must be correlated with the relevant endogenous variables and must not correlate with the error term (Angrist and Pischke 2009). The former can be tested for using the procedure developed by Stock and Yogo (2005) to ascertain the existence of weak instruments. The latter, the exclusion restriction, can be split into two subcriteria including (a) independence from the outcome, conditional on the covariates (tested by including the instruments in the main equation and determining their individual and joint statistical significance), and (b) having no effect on outcomes other than through first-stage channels (tested for using overidentification tests, assuming at least one instrument is valid).

All analyses are performed using *Stata 11* and *ivreg2* (Baum, Schaffer, and Stillman 2010). All regressions incorporate GSS probability weights and estimated standard errors are robust to heteroscedasticity.

RESULTS

Table 1 presents descriptive statistics. First-stage results are presented in Table 2. All instruments are strong, both individually and jointly, with partial *F*-statistics being very large. In addition to the predicted relationships between average SRHS and individual SRHS and between the temporal distance variable and income, other relationships are apparent. It is not surprising that gender/age/education matched fair/poor average health and is negatively

correlated with equivalized income, as worse health makes it difficult to maintain and advance a career. However, it is unknown why the temporal distance variable negatively correlates with poor/fair health. This correlation is the weakest among the instruments and is thus of little consequence.

Table 1: Descriptive Statistics: General Social Survey (1975–2010)

<i>Variables</i>	<i>Mean</i>	<i>SD</i>
Dependent variable		
Happiness (1–3)	1.808	0.634
Equivalized income (in \$10,000s, 2010 constant dollars)	3.452	2.780
Poor/fair health	0.233	—
Poor health	0.052	—
Fair health	0.181	—
Good health	0.455	—
Excellent health	0.312	—
Demographics		
Female	0.549	—
Ages 25–34	0.228	—
Ages 35–44	0.211	—
Ages 45–54	0.164	—
Ages 55–64	0.129	—
Ages 65–74	0.100	—
Ages 75 and older	0.063	—
Black	0.120	—
Other race	0.044	—
Married	0.537	—
Divorced	0.130	—
Separated	0.034	—
Widowed	0.093	—
Elementary school	0.026	—
Junior high school	0.181	—
High school	0.522	—
Associates degree	0.056	—
Bachelor's degree	0.145	—
Graduate school	0.070	—
Spring	0.656	—
Summer	0.048	—
Fall	0.018	—
Instruments		
Number of days after Tax Day	10.062	32.380
Intelligence proxy (1–3)	2.815	0.445
Average poor health (by age, sex, degree)	0.053	—
Average fair health (by age, sex, degree)	0.182	—
Observations	28,570	

Notes: Black oversample (only present in 1982 and 1987) and Spanish language sample are omitted.

Table 2: First-Stage Regressions

Variables	Natural Log of Equivalized Income		Poor/Fair Health	
	Coefficient	t-statistic	Coefficient	t-statistic
Demographics				
Female	0.010	0.00	-0.016	-3.30*
Ages 25-34	0.187	7.58*	0.012	1.33
Ages 35-44	0.355	14.43*	0.009	0.96
Ages 45-54	0.512	19.89*	0.009	0.83
Ages 55-64	0.549	20.32*	0.012	1.04
Ages 65-74	0.362	12.79*	-0.002	-0.17
Ages 75 and older	0.330	9.89*	0.016	0.97
Black	-0.324	-17.70*	0.041	4.86*
Other race	-0.185	-5.16*	0.052	3.75*
Married	0.280	17.03*	-0.034	-4.84*
Divorced	-0.014	-0.64	0.025	2.49*
Separated	-0.130	-3.12*	0.043	2.64*
Widowed	0.061	2.25*	0.010	0.77
Elementary school	-0.269	-6.33*	-0.034	-1.64
Junior high school	-0.126	-4.81*	-0.001	-0.12
High school	0.216	7.83*	0.000	-0.01
Associate's degree	0.351	9.96*	0.002	0.15
Bachelor's degree	0.580	18.53*	0.004	0.27
Graduate school	0.768	23.46*	-0.007	-0.44
Spring	0.106	8.92*	-0.023	-3.91*
Summer	0.128	2.76*	-0.036	-1.86
Fall	0.108	1.20	-0.081	-2.32*
Instruments				
Number of days after Tax Day	0.003	4.64*	-0.0004	-2.07*
Intelligence proxy	0.266	19.20*	-0.050	-7.41*
Average poor health	-0.342	-6.73*	0.980	41.64*
Average fair health	-0.749	-9.62*	0.947	27.42*
Constant	-0.676	-10.42*	0.249	8.79*
R^2	0.29		0.18	
F	215.40*		139.33*	
Strength of instrument set				
Partial F (standard)	135.76*		647.47*	
Partial F (Angrist and Pischke)	112.07*		477.38*	
Observations	28,570		28,570	

Notes: Year indicators included, but not reported.

* $p \leq .05$.

Table 3 presents the 2SLS regression results along with the OLS results. In Table 3, the joint strength of the instruments is such that maximal IV relative bias is less than 5 percent (Kleibergen-Paap rk Wald F -statistic: 83.03 > Stock-Yogo critical value: 11.04) and the IV maximal size distortion is less

Table 3: 2SLS versus OLS Regressions of Probit-Adapted Happiness

<i>Variables</i>	<i>2SLS</i>		<i>OLS</i>	
	<i>Coefficient</i>	<i>t-statistic</i>	<i>Coefficient</i>	<i>t-statistic</i>
Key variables				
ln(equivalized income)	0.194	3.41*	0.074	9.90*
Fair/poor health	−0.234	−3.57*	−0.378	−26.62*
Demographics				
Female	0.083	6.25*	0.067	6.09*
Ages 25–34	−0.117	−4.84*	−0.092	−4.37*
Ages 35–44	−0.167	−5.40*	−0.120	−5.30*
Ages 45–54	−0.172	−4.44*	−0.102	−4.24*
Ages 55–64	−0.101	−2.40*	−0.022	−0.86
Ages 65–74	0.082	2.24*	0.141	5.19*
Ages 75 and older	0.108	2.66*	0.166	5.08*
Black	−0.121	−4.63*	−0.155	−8.21*
Other race	−0.004	−0.14	−0.023	−0.84
Married	0.275	12.45*	0.305	18.79*
Divorced	−0.074	−3.44*	−0.071	−3.36*
Separated	−0.160	−4.59*	−0.169	−5.00*
Widowed	−0.139	−4.93*	−0.129	−4.67*
Elementary school	0.069	1.37	0.038	0.83
Junior high school	−0.040	−1.47	−0.046	−1.78
High school	−0.052	−1.66	−0.025	−0.92
Associate's degree	−0.019	−0.44	0.024	0.66
Bachelor's degree	−0.014	−0.28	0.052	1.68
Graduate school	0.002	0.03	0.088	2.57*
Spring	−0.003	−0.20	0.007	0.52
Summer	0.013	0.37	0.038	1.16
Fall	−0.075	−0.99	−0.064	−0.87
Constant	−0.273	−5.49*	−0.234	−5.10*
Weak instrument test				
Kleibergen-Paap rk Wald <i>F</i>		83.03		—
5% maximal IV		11.04		—
relative bias (critical value)				
10% maximal IV		16.87		—
size (critical value)				
Overidentification test				
Hansen's <i>J</i> (<i>p</i> -value)		1.31 (<i>p</i> = .52)		—
Endogeneity tests				
ln(equivalized income) χ^2 (<i>p</i> -value)		4.26 (<i>p</i> = .04)		—
Poor/fair health status χ^2 (<i>p</i> -value)		3.92 (<i>p</i> = .05)		—
Observations		28,570		28,570

Notes: Parameters are interpreted as standard deviations of happiness. Year indicators are included, but not reported. 2SLS, two-stage least-squares; OLS, ordinary least-squares.

**p* ≤ .05.

than 10 percent (Kleibergen-Paap rank Wald F -statistic: 83.03 > Stock-Yogo critical value: 16.87). The set of instruments is thus sufficiently strong.

Simple exclusion restriction tests find that none of the instruments are statistically significant when included in the main equation (equation 3) individually or jointly, failing to reject the null hypothesis that the instruments are independent of the outcome, conditional on the covariates. Similarly, overidentification tests fail to reject the null hypothesis that the overidentifying instruments are exogenous.

Finally, endogeneity tests find that the 2SLS estimates are statistically different from the OLS estimates for both the natural log of equivalized income ($\chi^2 = 4.26$, $p = .04$) and health status ($\chi^2 = 3.92$, $p = .05$). The corrected income parameters are almost three times as large as the uncorrected income parameters, consistent with previous work that attempts to correct for the endogeneity of household income in SWB equations (Luttmer 2005; Powdthavee 2009). The results suggest that the OLS estimates of health status are also biased downward.

Correcting these biases has a large impact on the valuation of SRHS. The implicit derivative is calculated as follows:

$$\partial y / \partial h = -[\beta_1 / (\beta_2 / \text{income})] \quad (6)$$

Using the implicit derivative, the 2SLS value of moving from good/excellent health to poor/fair health is equivalent to an annual equivalized income loss of \$41,654 ($p = .05$), which represents a long-run average. In other words, moving from good/excellent health to poor/fair health (a year of reduced health) reduces the happiness of the average person by the same amount that the loss of \$41,654 in equivalized income (a year of reduced income) would reduce the happiness of the average person. This result also suggests that the OLS parameters are biased, as the value of the same derivative in the OLS model is equivalent to an income loss of \$175,675 ($p < .05$).

Additional results parallel the general findings in the literature on happiness. Females are happier than males (Alesina, Di Tella, and MacCulloch 2004). Age exhibits a U-shaped association with happiness (Blanchflower and Oswald 2004; Ferrer-I-Carbonell and Gowdy 2007). African Americans are less happy than Caucasians (Thoits and Hewitt 2001). Being married is associated with greater happiness than being single, and being separated is associated with less happiness than being divorced (Helliwell 2003).

DISCUSSION

This study applied SWB valuation to ascertain the value of SRHS with U.S. data spanning a 36-year period using a set of valid instrumental variables to correct for the endogeneity of health and equivalized annual household income. The instruments included a proxy for intelligence, a temporal version of the popular “distance” instrument, as well as average population-level SRHS measures matched on gender/age/education.

Correcting for endogeneity drastically reduced the estimated annual valuation of a loss of health status from OLS estimates of $-\$175,675$ to 2SLS estimates of $-\$41,654$. To determine whether the corrected valuation is large, it is compared to median annual household income in the United States. However, as household income is equivalized in this study by adjusting for household composition and calculated over a 36-year period, the most appropriate comparison is similarly adjusted median annual household income, calculated across the same period. This figure is $\$27,109$. Thus, the lost value of moving from good/excellent health to fair/poor health is 1.8 times median equivalized annual household income.

This study is not without limitations. The estimated valuation only includes the value of health to the individual. It does not include external effects such as those experienced by family members (Bobinac et al. 2010). Thus, it is underestimated to the extent that this additional impact is relevant. In addition, while only approximately 5 percent of respondents refused to provide family income information, these respondents are likely disproportionately represented at the tails of the income distribution, which may result in small parameter biases. However, the estimated valuation should be externally valid for almost all of the U.S. population. Future studies should employ larger annual datasets where multiple imputation methods can be reliably used for missing data issues. In addition, it may be the case that the value of SRHS varies by demographic factors. This was not examined here due to space limitations but could be determined by applying the methodology to separate subsets, each containing the group of interest.

The results presented here use unique instruments not used in previous studies. However, future studies should consider the use of alternative instruments.

Finally, many analysts will want a health measure that can be transformed to quality-adjusted life-years (QALYs). While this is not possible in the

Table 4: Selected Datasets to Value Health and Health Care Using SWB Valuation

<i>US Datasets</i>	<i>SWB Measures</i>
General Social Survey (most years)	Happiness
Community Tracking Study Household Survey (2001, 2003)	Happiness
National Health Interview Survey (2001 only)	Happiness
	Life Satisfaction
Behavioral Risk Factor Surveillance Survey	Life Satisfaction
Moving to Opportunity	Happiness
National Survey of Family and Households	Happiness
Collaborative Psychiatric Epidemiology Surveys	Happiness
	Life Satisfaction
American's Changing Lives	Life Satisfaction
International Datasets	
British Household Panel Survey	Life Satisfaction
Household, Income and Labor Dynamics in Australia	Life Satisfaction

current study, it can be done using the SF-36 (Brazier, Roberts, and Deverill, 2002; Grieve et al. 2008). One would simply substitute QALYs for SRHS in the relevant equations. For a discussion on using SWB to measure quality in QALYs, see Dolan (2008a).

The goal of this study has been to introduce a methodology that is new to the field of health services research, but which can be applied to value many health services and aspects of health that are difficult to otherwise value. As this study demonstrates, health is an extremely valuable commodity and health services researchers should consider extending this approach to other health-related measures for which fundamental market relationships are absent. Selected datasets are listed in Table 4.

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NOTES

1. The GSS asked a subset of respondents both the four-level and five-level SRHS question in 2002, 2004, 2006, and 2010. The two measures correlate at 0.87 with 16.4 percent reporting very good/excellent health using the five-level measure and 19.1 percent reporting good/excellent health using the four-level measure.
2. Happiness regressions in the form used by Carrieri (2012) were estimated where HP is happiness, H is SRHS, H^* is average “peer” health status, Z is the set of demographic variables used above, and T is a vector of year and season indicators:

$$HP_i = \beta_0 + \beta_1 H_i + \beta_2 H_i^* + \beta_3 \frac{H_i}{H_i^*} + \beta_4 Z + \beta_5 T + \varepsilon,$$

when H^* was measured using matched gender/age/education categories using the entire available national GSS sample for all years, β_2 and β_3 were individually and jointly statistically insignificant. This suggests that it is necessary for respondents to have knowledge of the health of individuals in the comparison group before health comparisons affect respondents’ happiness level. Therefore, average levels of SRHS of individuals who are unknown to the respondent, but who are sociodemographically similar, are exogenous to the respondents’ happiness.

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