THE BENEFITS OF MORTALITY RISK REDUCTION: HAPPINESS SURVEYS VS. THE VALUE OF A STATISTICAL LIFE

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A principal component of many benefit-cost analyses (BCAs) of health, safety, and environmental regulations is the valuation of the fatality risk effects of the underlying policy. Government agencies currently value these expected effects using estimates of the value of a statistical life (VSL), that is, the tradeoff rate between money and very small risks of death. This measure corresponds to BCA's theoretically appropriate benefits measure, which is society's willingness to pay for the risk reduction. Here, I will review the VSL approach, compare it to suggested alternatives that use happiness measures of well-being, and address some of the misunderstandings that may be contributing to some researchers' advocacy for the use of happiness scores for policy valuation. The VSL serves as a focal point of the well-being analysis by Professors John Bronsteen, Christopher Buccafusco, and Jonathan Masur (Bronsteen et al.).[1] As VSL is the fatality risks-benefits measure conventionally used in BCA, it also generally serves as a principal reference point for guiding public-policy valuations, which are the focus of Professor Matthew Adler's article.[2]

A common approach to estimating VSL is the use of wage premiums that workers receive for occupational fatality risks.[3] It is

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1. *See* John Bronsteen, Christopher Buccafusco & Jonathan S. Masur, *Well-Being Analysis vs. Cost-Benefit Analysis*, 62 DUKE L.J. 1603, 1670–79 (2013) (discussing VSL's limitations and possible alternative measures).

2. Matthew D. Adler, *Happiness Surveys and Public Policy: What's the Use?*, 62 DUKE L.J. 1509 (2013).

3. *See, e.g.*, NAT'L CTR. FOR ENVTL. ECON., U.S. ENVTL. PROT. AGENCY, VALUING MORTALITY RISK REDUCTIONS FOR ENVIRONMENTAL POLICY: A WHITE PAPER 35–43 (2010), *available at* http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0563-1.pdf/$file/EE-0563-1.pdf (examining hedonic wage studies used to determine VSL); Memorandum from Polly Trottenberg, Under Sec'y for Policy, U.S. Dep't of Transp., & Robert Rivkin, Gen. Counsel, U.S. Dep't of Transp., to the Secretarial Officers & Modal Adm'rs of the U.S. Dep't of Transp.

instructive to start with the theoretical underpinnings of VSL in this context, which in turn indicate the nature of the relationship of the components of the VSL calculation to individual utility. The empirical estimate of VSL based on wage-risk tradeoffs is the difference between one's utility when alive and when dead, divided by the expected marginal utility of income.[4] Thus, a key building block of the formula is a measure of how great one's utility, or well-being, is when alive as compared to how great one's utility is when deceased, which also might be thought of as one's bequest. The utility functions in this analysis are von Neumann-Morgenstern utility functions that are conditional on health status and are generally defined only up to a positive linear transformation.[5] Adding a constant to the utility functions or multiplying the utility functions by a positive constant does not alter their structure, but it does affect their level. To give the difference in utility functions cardinal significance, the formula for VSL divides the difference in utilities by the expected marginal utility of income, which serves to normalize the units of the utility-difference expression. As a consequence of this mathematical structure, VSL serves as a cardinal measure of preferences with respect to fatality risks. For small changes in the risk of death, VSL is a measure of both the worker's willingness-to-pay value for reduced risk and willingness-to-accept value for increased risk. Government agencies have used the individual valuations of risk implied by estimates of VSL to value society's willingness to pay for the risk reduction.[6]

Although happiness scores elicited in surveys are not tantamount to utility levels, many researchers have advocated them as measures of well-being. However, unlike the VSL formulation, well-being measures have no explicit economic content and no cardinal

(Mar. 8, 2013), *available at* http://www.dot.gov/sites/dot.dev/files/docs/VSL%20Guidance%202013.pdf (utilizing VSL estimates calculated by wage-premium studies). Examples of the VSL estimates used in policy contexts appear in W. Kip Viscusi, *The Devaluation of Life*, 3 REG. & GOVERNANCE 103, 107 (2009).

4. *E.g.*, W. Kip Viscusi & Joseph E. Aldy, *The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World*, 27 J. RISK & UNCERTAINTY 5, 7–8 (2003).

5. *See* ANDREU MAS-COLELL, MICHAEL D. WHINSTON & JERRY R. GREEN, MICROECONOMIC THEORY 173–74 (7th prtg. 2009).

6. Viscusi, *supra* note 3, at 114 tbl.2 (providing 27 examples of the U.S. Environmental Protection Agency (EPA) using VSL); *id.* at 108 tbl.1 (providing 13 examples of uses of the VSL by other agencies). For general agency guidance on using VSL in policy evaluation, see OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, CIRCULAR A-4, REGULATORY ANALYSIS, at 29–31 (2003), *available at* http://www.whitehouse.gov/sites/default/files/omb/assets/omb/circulars/a004/a-4.pdf.

significance. A representative well-being survey question asks the respondent to rate his or her happiness or satisfaction with life on a numerical scale such as 0 to 10, 1 to 10, or 1 to 7.[7] At a most fundamental level, how should a person even think about such a question? What is the reference point for such an assessment? Should the assessment depend on today's weather, how this week compares to last week, or how happy one would be in a world without budget constraints? If you have a permanent disability, then you may nevertheless feel pretty good about how your life is going on a particular day, but you might be much happier if you were not disabled—and you would give a different happiness score if the no-disability state were in the reference set. A similar reference-point issue affecting this thought experiment is whether people compare their well-being on a relative basis to others, and if so, how people construct this comparison set.[8] A person in Liberia with an income of one dollar per day would be in the top 15 percent of that population's income distribution and may have a relatively high happiness score when answering the question in comparison to fellow Liberians. If, however, the comparison is relative to the well-being in more affluent countries or based on some absolute metric, the person might recalibrate the index and give a different score. These incomparability and reference-point problems undermine the validity of international comparisons of well-being across countries and also lead to underestimation of the effect of income on happiness.[9]

In addition to lacking any theoretical grounding or mechanisms by which people can conceptualize the appropriate response to a well-being question, such scales are an inappropriate basis for benefit assessment for a variety of reasons. Happiness scores share the

7. *See* Richard R. Layard, G. Mayraz & S. Nickell, *The Marginal Utility of Income*, 92 J. PUB. ECON. 1846, 1848 tbl.1 (2008) (collecting examples of well-being studies). *See generally* Adler, *supra* note 2 (presenting representative survey texts and providing a review and critique of such questions).

8. Such relative comparisons are fraught with error, as shown by Professors Thomas J. Kniesner & W. Kip Viscusi, *Why Relative Economic Position Does Not Matter: A Cost-Benefit Analysis*, 20 YALE J. ON REG. 1, 9–19 (2003).

9. The lack of comparability of U.S. and Dutch scales and the underestimation of the effect of income on happiness are documented in Arie Kapteyn, James P. Smith & Arthur Van Soest, *Are Americans Really Less Happy with Their Incomes?*, 59 REV. INCOME & WEALTH 44 (2013).

inherent inadequacies of ordinal measures.[10] Consider an example of ranking the members of a basketball team in terms of height where 5 is the score for the tallest player and 1 is the score for the shortest player. Unless the tallest player is 5 times taller than the shortest player, the scale cannot serve as a cardinal measure. For much the same reasons, if the scale is to have cardinal significance, moving from 10 to 8 on the subjective well-being scale should be twice as valuable as moving from 8 to 7 and have the same value as moving from 3 to 1. What "twice as valuable" even means cannot be tested because there is no external metric to assess the well-being level that corresponds to a particular happiness score.

For the scales to have meaning, the intervals for different respondents must represent identical welfare effects across people. Such an intractable, interpersonal comparison problem does not arise in benefit assessments based on monetary willingness-to-pay amounts. Bronsteen et al. claim that interpersonal comparisons under BCA are not possible if compensation is not paid to the policy losers following the Kaldor-Hicks compensation criterion.[11] However, this is an irrelevant point that simply is not true. The monetary valuations of the winners and losers can be compared under BCA. For a policy for which the benefits exceed the costs, the gainers from the policy can potentially compensate the losers and still be better off than before. But unless compensation is actually paid to the losers, the possibility of a potential compensation scheme that can make the losers no worse off than before is not morally compelling. As a practical matter, there will be winners and losers from almost all government policies, but the entire portfolio of government policies, including tax policies, may address distributional inequities. Even under a social well-being approach, some people will experience an increase in well-being and others will experience a decrease such that unless compensation is paid to all the losers, there is a problem of violating the Kaldor-Hicks criterion. But unlike the VSL approach, the use of well-being measures creates the additional problem of not having any sound basis to compare the effects to those who benefit from the policy and those who do not.

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10. Ordinal measures also cannot be used in the same manner as cardinal variables in regression contexts or for policy assessments. Professor Adler also discusses this problem. *See* Adler, *supra* note 2, at 1590–92.

11. *See* Bronsteen, Buccafusco & Masur, *supra* note 1, at 1670–79 (discussing VSL's limitations and possible alternative measures).

The well-being scales are also very coarse. There are very few government policies that would alter people's well-being by an entire point, which corresponds to a welfare effect of about 10 percent, depending on the scale being used. The only example of a policy that substantially affected my well-being was the institution of a draft lottery from 1969 to 1972 during the Vietnam War. Prior to the lottery system, college students were subject to the draft only after graduating. With the lottery system, college students' birthdays were drawn at random and assigned a lottery number. Those with favorable lottery numbers, such as myself, were assigned a lower priority in the draft and were exempted from military service. Few government policies have such life-changing consequences. Given the myriad of government policies that exist, perhaps the elimination of programs associated with an entire executive-branch agency would not alter one's well-being score. This coarseness makes the well-being score approach of little help for assessing diverse policy outcomes, few of which are truly life-changing.

Rating scales such as those used in well-being studies also are bounded from above and below. If I am having a bad day, I might say that this is a 0, but is that score the same as being dead? And if 0 is the worst outcome, is having a bad day as undesirable from a welfare standpoint as being captured and tortured by terrorists? Similarly, at the upper-end of the scale, a good day that merits a score of 8 gives one very little room for improvement. A middle-income person with a starting point score of 8 might be considerably happier if given Bill Gates's entire fortune, but a 10-point happiness index limits the jump in well-being to 2 points. Any study that imposes an upper bound on the well-being score may lead to an erroneous conclusion that money does not increase happiness to a great extent. The numerical ordinal scale for happiness creates ceiling and floor effects, whereas there is no such limitation associated with conventional willingness-to-pay or willingness-to-accept measures used in BCA.

The manner in which the well-being proponents would value lives is as follows: adhering to the approach that Bronsteen et al. advocate, if one has a constant well-being score throughout one's life, the benefit value is the happiness score multiplied by the remaining life expectancy, and there is no discounting of the values.[12] A newborn baby with a life expectancy of eighty years consequently is eighty times as valuable as an elderly person with one remaining expected

12. *Id.* at 1663–64.

year of life. Similarly, a policy that extends the life of an elderly person with a well-being score of 7 by one more year would have the same value as letting that elderly person die and making seven people a bit happier by raising their scores from 6 to 7 for one year.

In addition to the questionable linearity assumption, the well-being approach makes no allowance for the role of probabilistic effects. VSL provides measures for one's expected death in situations in which there are small risks of death. In contrast, the well-being value of 7 for the elderly person in the example above is the pertinent value whether it is an identified life that is being extended with certainty or whether it is one expected life that is being saved as the result of a reduction in a small probability of the risk of death. Unlike the insensitivity to the probability of death of the well-being unit-value approach, society generally accords quite different values to identified lives and statistical lives, as do the individuals facing the risk of death.

The absence of discounting in the Bronsteen et al. formulation of the well-being value of lives is also problematic. They give an example of a person who has a well-being score of 7.4 for thirty years, leading to a well-being value of that person's life of 30×7.4, or 222.48.[13] In a world in which there is no discounting, as in their example, the well-being value of a life is unchanged if the life saved is deferred, such as by an anti-cancer policy that reduces risks after a decade-long latency period. More remote policy impacts also are accorded the same value. The value of extending the life of someone who will be alive one hundred years from now has the same value as an immediate life extension of the same duration. In a world in which it is possible to invest and earn interest, then, in the absence of discounting, if the cost of reducing death risks is constant, it will always be desirable to postpone lifesaving efforts. This is because one can invest current resources, save more future lives, and generate more well-being units instead of allocating funds to save lives now.

The misunderstandings of Bronsteen et al. also extend to their discussion of VSL methodology. They express dismay that there is substantial heterogeneity of the VSL.[14] But VSL is not a universal constant such as e or π. People will differ in their risk/money tradeoffs

13. *Id.* at 1642.

14. *See id.* at 1652 ("[T]he fact that rich and poor people (who presumably care equally, or at least comparably, about staying alive) would be willing to pay vastly different amounts to avoid a 1-in-10,000 risk of death illustrates the inadequacy of [BCA] for valuing lives.").

in much the same way as they differ in preferences for other economic goods. Empirical estimates using VSL have a median value of $7 million (in year 2000 dollars) based on my meta-analysis with Professor Joseph Aldy.[15] There is considerable heterogeneity in the VSL because the populations in the studies differ in many fundamental respects, such as age and wealth. There also may be differences in econometric methodology because the studies vary in quality in this field as in other areas of economic inquiry. The risk data used in these studies has also improved over time, and as a result, the estimates using the new Census of Fatal Occupational Injuries data tend to involve less measurement error and are in a narrower range than in previous studies.[16] The VSL estimates used by government agencies from 1996 to 2008 have ranged from $6.8 million to $9 million (in year 2008 dollars) per expected life saved at the U.S. Environmental Protection Agency (EPA)[17] and have been around $6.2 million (in year 2008 dollars) at several other agencies.[18] Some agencies are considering updating their assessments using more recent fatality rate data.

Bronsteen et al., as well as other commentators, are disturbed that there are wealth effects that influence the VSL because more affluent individuals have a higher VSL.[19] This dependence on wealth is not a drawback but is an attractive property that is consistent with a more general positive income elasticity of health. Indeed, one might well question the validity of any well-being scale that did not exhibit a positive relationship to financial resources. Greater wealth enlarges one's choice set, and enlarging one's choice set should always raise well-being because a person always has the option of not spending the money or giving it away.

There are three noteworthy observations with respect to wealth effects and VSL, which I first linked to wage-risk tradeoffs over three decades ago. First, more affluent people are willing to invest more in

15. Viscusi & Aldy, *supra* note 4, at 18.

16. The Census of Fatal Occupational Injuries is a comprehensive census of all job-related fatalities. *See* Joyce M. Northwood, Eric F. Sygnatur & Janice A. Windau, *Updated BLS Occupational Injury and Illness Classification System*, MONTHLY LAB. REV., Aug. 2012, at 19, 19. The narrowing of the estimated range of VSL estimates is discussed in Thomas J. Kniesner, W. Kip Viscusi, Christopher Woock & James P. Ziliak, *The Value of a Statistical Life: Evidence from Panel Data*, 94 REV. ECON. & STAT. 74, 85–86 (2012).

17. *See* Viscusi, *supra* note 3, at 114 tbl.2.

18. *See id.* at 108 tbl.1.

19. Bronsteen, Buccafusco & Masur, *supra* note 1, at 1652.

risk reduction than are poorer people and are less willing to boost their income with earnings from a potentially dangerous job.[20] As a result, more affluent people have a higher VSL than less affluent people. Such heterogeneity in preferences is manifested in consumer choices; for example, more expensive automobiles often come equipped with very expensive safety features that would not be attractive to purchasers of more basic automobiles. Requiring that all cars have the same safety features as an $80,000 car would lower the welfare of the purchasers of inexpensive cars. Second, notwithstanding the theoretical and empirical variation in VSL with wealth, I know of no instances in which government agencies have assigned different VSL levels to people in different income groups.[21] By using a uniform VSL across different populations, agencies engage in an implicit form of income redistribution, as benefits to the poor receive a greater weight than is justified by their VSL and benefits to the rich are undervalued. The principal exception to this uniformity is that agencies adjust the VSL over time for increases in societal income levels.[22] Third, even though government agencies do not make income-based distinctions in setting the VSL, I advocate doing so, particularly in situations in which the beneficiaries of the policy are, in effect, paying for the greater level of safety—for example, airline passengers who must pay a higher ticket price for travel on planes subject to expensive safety regulations.[23]

Because lifesaving efforts do not convey immortality, the age variation of VSL has been a major area of economic inquiry. Contrary to the claims by Bronsteen et al.,[24] there is no barrier to recognizing age variations in VSL in a BCA. However, as a practical matter, agencies seldom do so. Early empirical estimates of the VSL-

20. The positive income elasticity of VSL is documented by Viscusi & Aldy, *supra* note 4, at 36–43.

21. The EPA and the U.S. Department of Transportation (DOT) guidance documents and the Office of Management and Budget Circular A-4 mentioned above make no provision for recognizing differences across income groups, though adjustments for increases in societal income levels over time are allowed. *See* NAT'L CTR. FOR ENVTL. ECON., *supra* note 3, at 10–11; OFFICE OF MGMT. & BUDGET, *supra* note 6, at 30; Memorandum from Tyler D. Duvall & D.J. Gribbin, *supra* note 3, at 1.

22. The DOT adopted the income elasticity estimates based on an article by Professors Viscusi and Aldy. Memorandum from Tyler D. Duvall & D.J. Gribbin, *supra* note 3, at 3–4; *see also* Viscusi & Aldy, *supra* note 4.

23. W. KIP VISCUSI, FATAL TRADEOFFS: PUBLIC AND PRIVATE RESPONSIBILITIES FOR RISK 28–29 (1992).

24. *See* Bronsteen, Buccafusco & Masur, *supra* note 1, at 1677–79.

age variation found a steadily declining pattern with age,[25] in part because available fatality-rate data did not permit a more refined analysis. More recent studies using age-specific fatality rates by industry and occupation have generated evidence that there is an inverted U-shaped relationship between the VSL and age, consistent with economic theory and the rise and fall of individual income over the life cycle.[26] VSL does taper off with age, but the VSL for sixty-year-olds remains higher than that of twenty-year-olds.[27] Similarly, the value of a statistical life year (VSLY) rises and falls over the life cycle.[28] Procedures that assume a constant value per year of life such as the well-being approach and quality-adjusted life years (QALYs) consequently are not accurate reflections of age-related variations in willingness-to-bear risks.

Despite the prominence of age-related studies in the literature, government agencies have rarely incorporated age adjustments into VSL. A notable exception is the EPA's Clear Skies Initiative, in which the EPA included in a sensitivity analysis a 37 percent senior discount for those over age seventy.[29] This incident generated substantial controversy, particularly among senior citizen groups, and government agencies subsequently have not made age adjustments. I believe the resistance would be even greater to the well-being unit approach because that methodology makes the valuation of lives a linear function of remaining life expectancy, leading to a much greater senior discount than in the EPA study.

The estimates of the VSL based on labor-market risks largely pertain to acute risks of death, but the VSL approach is not restricted to such risks. The literature has addressed a wide variety of risks that affect wages, prices, or stated willingness-to-pay values in surveys. Consider two of the most prominently featured alleged omissions: cancer and deaths from terrorist attacks. First, are VSL estimates pertinent for cancer cases, which involve morbidity effects different

25. *See* Viscusi & Aldy, *supra* note 4, at 50–53 (noting that most early studies estimated a value per life year, which will lead to a lower VSL for older people, who have shorter remaining life expectancy).

26. *E.g.*, Joseph E. Aldy & W. Kip Viscusi, *Adjusting the Value of a Statistical Life for Age and Cohort Effects*, 90 REV. ECON. & STAT. 573 (2008).

27. *See id.* at 580 ("While this value is below the peak VSL over the life cycle, these older workers' VSLs are above the VSLs for very young workers.").

28. *Id.*

29. U.S. ENVTL. PROT. AGENCY, TECHNICAL ADDENDUM: METHODOLOGIES FOR THE BENEFIT ANALYSIS OF THE CLEAR SKIES INITIATIVE 35–36 (2002), *available at* http://www.epa.gov/clearskies/tech_adden.pdf.

from those for acute job accidents? The VSL literature can and has evaluated cancer risks. I have been involved in three such studies, one of which involved imputing the VSL based on the effect on housing prices of cancer risks from hazardous waste sites, and the other two studies were stated-preference studies.[30] The EPA funded two of these studies, and has proposed using a cancer premium of 50 percent while it refines estimates of the pertinent VSL level for cancer.[31] Second, can the VSL methodology address differences in the valuation of risks of death from terrorism? Such deaths are bundled with national security concerns and may be valued differently than other fatality risks. I have found that terrorism risks are valued twice as highly as deaths from natural disasters.[32] As the terrorism and cancer examples indicate, there is no barrier to generalizing the VSL approach to different kinds of deaths.

Finally, some of the reservations of Bronsteen et al. with respect to VSL are regarding the details of the estimation. They worry that workers may not know their job risks or be able to think sensibly about small risks.[33] But thinking about actual job risks when a worker can observe working conditions and job injuries is quite different from valuing hypothetical risks in a survey context. The empirical results in the VSL literature are very similar using objective and subjective risk measures.[34] If the measurement error is random, it will tend to bias the estimates downward. However, the robustness of the results to various instrumental-variables estimates, which is an econometric approach that addresses potential measurement error, suggests that with the current available fatality-rate data this is not a major concern.[35]

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30. Ted Gayer, James T. Hamilton & W. Kip Viscusi, *Private Values of Risk Tradeoffs at Superfund Sites: Housing Market Evidence on Learning About Risk*, 82 REV. ECON. & STAT. 439 (2000); Wesley A. Magat, W. Kip Viscusi & Joel Huber, *A Reference Lottery Metric for Valuing Health*, 42 MGMT. SCI. 1118 (1996); W. Kip Viscusi, Joel Huber & Jason Bell, *Assessing Whether There Is a Cancer Premium for the Value of a Statistical Life*, 22 HEALTH ECON. (forthcoming 2013).

31. NAT'L CTR. FOR ENVTL. ECON., *supra* note 3, at 25–26.

32. W. Kip Viscusi, *Valuing Risks of Death from Terrorism and Natural Disasters*, 38 J. RISK & UNCERTAINTY 191, 203 (2009). I am currently refining these estimates under a contract for the University of Southern California's CREATE project funded by the U.S. Department of Homeland Security.

33. *See* Bronsteen, Buccafusco & Masur, *supra* note 1, at 1649 ("People's minds are not designed to differentiate between exceedingly small risks and infinitesimally small risks, and when asked to do so rationally, they frequently fail.").

34. Some of these comparisons are discussed in Viscusi & Aldy, *supra* note 4, at 10, 65 n.5.

35. For a diverse series of econometric tests, see Kniesner et al., *supra* note 16, at 78–85.

Both VSL and BCA remain generally accepted methodologies among economists and government agencies. They serve a valuable function in enabling government agencies to assess and compare the performance of government policies. Happiness and well-being studies may have a useful role to play in the psychology-and-economics literature generally, but given the current state of research in the area, they do not provide either an alternative or a supplementary methodology for policy assessment.