
NATURAL RESOURCES JOURNAL

Volume 23
Issue 3 *Symposium on Environmental Management: The Policy Perspective*

Summer 1983

Psychological Considerations in Valuing Health Risk Reductions

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1. INTRODUCTION

Environmental and health economists have long sought a measure of the economic value of lives saved or lost. While the goal is sometimes descriptive, as in cost-of-illness studies, we are usually more concerned with the normative problem of choosing among alternative projects or programs having different health consequences. Usually such choice problems are complicated by uncertainty, which not only adds a dimension to the economic valuation problem, but also raises difficult normative questions even when financial concerns are absent, as in medical decision making for the fully-insured individual patient.

The early history of the quest for an economic value of lives saved was dominated by the human capital approach, which is based on the economic contribution of persons to society.[1] Human capital is an *ex post* measure, focusing on the lives ultimately saved or lost and not on the probabilistic process by which those lives are selected.[2]

Later, economists such as Schelling and Mishan advocated statistical approaches based on willingness to pay for individual changes in mortality probabilities.[3] The willingness-to-pay (WTP) approach has been implemented both in labor market studies of revealed preference[4] and in direct

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†Supported by a grant from the Alfred P. Sloan Foundation to the Department of Biostatistics and grant CR807809 from the Environmental Protection Agency to Interdisciplinary Programs in Health, Harvard School of Public Health. The contents do not necessarily reflect the views of the Sloan Foundation or the Environmental Protection Agency.

1. B. WEISBROD, ECONOMICS OF PUBLIC HEALTH (1961); Mushkin, *Health as an Investment*, 70 J. POL. ECON. 129 (1962); Rice, *Estimating the Cost of Illness*, 57 AM. J. PUB. HEALTH 424 (1967).

2. As such, the human capital value may be applied either to identified lives saved or lost, or to expected numbers of statistical lives saved or lost.

3. Mishan, *Evaluation of Life and Limb: A Theoretical Approach*, 79 J. POL. ECON. 687 (1971); Schelling, *The Life You Save May Be Your Own*, PROBLEMS IN PUBLIC EXPENDITURE ANALYSIS 127 (S. Chase ed. 1968).

4. *See, e.g.*, M. BAILEY, REDUCING RISKS TO LIFE: MEASUREMENT OF THE BENEFITS (1980); Smith, *The Feasibility of an "Injury Tax" Approach to Occupational Safety*, 38 LAW AND CONTEMP. PROB. 730 (1974); Thaler & Rosen, *The Value of Saving a Life: Evidence From the Labor Market*, HOUSEHOLD PRODUCTION AND CONSUMPTION: STUDIES IN INCOME AND WEALTH (N. Terleckyj ed. 1976); Viscusi, *Labor Market Valuations of Life and Limb*, 26 PUB. POL'Y. 259 (1978).

surveys.[5] Although willingness to pay is fundamentally an *ex ante* measure,[6] being based on the value of a change in the mortality probability, it is commonly converted into an *ex post* value of life by dividing the WTP by the corresponding probability decrement.[7]

Meanwhile, decision theory has been used to show that, for wide ranges of utility functions involving money and mortality, the willingness to pay for a change in the probability of death ought to depend, in certain predictable ways, on the baseline mortality probability and on the change in mortality probability.[8] Thus, the proposition that the normative value of life saving is context-dependent, suggested by risk analysts and psychologists,[9] has gained support from formal utility theory.

The dependence of willingness to pay on context seems to be borne out, descriptively at least, by the often-cited observation that our society seems to be willing to spend millions of dollars per life saved in some contexts, while refusing to spend only a few thousand dollars per life saved in others.[10] The following examples illustrate the dependence of the value of life saving on context:

- *Terminal Care versus Prevention.* A 1972 amendment to the Social Security Act made hemodialysis available, at federal expense, to all persons with end-stage kidney disease. The cost per year of life saved by this program is substantially greater than the cost per year of life saved by high blood pressure treatment programs, measles immunization, or many other less well funded preventive services.
- *Vinyl Chloride.* Soon after the discovery that vinyl chloride monomer

5. *See, e.g.*, M. JONES-LEE, THE VALUE OF LIFE (1976); ACTON, EVALUATING PROGRAMS TO SAVE LIVES: THE CASE OF HEART ATTACKS (1973) (Rand Corporation Report R-950-RC, Santa Monica).

6. Willingness-to-pay, like human capital, may be applied either to unidentified (i.e., statistical) lives, or to lives whose identity is or will become known. For this reason, the key distinction between human capital and willingness-to-pay is that between *ex post* vs. *ex ante* measures. We reserve for later discussion the distinction between the value of saving identifiable versus statistical lives.

7. *See, e.g.*, INSTITUTE OF MEDICINE, COSTS OF ENVIRONMENT-RELATED HEALTH EFFECTS (1981).

8. Jones-Lee, *The Value of Changes in the Probability of Death or Injury*, 82 J. POL. ECON. 835 (1974); Weinstein, Shepard & Pliskin, *The Economic Value of Changing Mortality Probabilities: A Decision Theoretic Approach*, 95 Q. J. ECON. 373 (1980).

9. *E.g.*, Fischhoff, Slovic, Lichtenstein, Read & Combs, *How Safe is Safe Enough? A Psychometric Study of Attitudes Toward Technological Risks and Benefits*, 9 POL'Y SCI. 127 (1978); Otway, *The Perception of Technological Risks* in TECHNOLOGICAL RISK 35 (M. Dierkes, S. Edwards and R. Coppock eds. 1980); Starr, *Societal Benefit versus Technological Risk*, 165 SCI. 1232 (1969); *see also* W. LOWRANCE, OF ACCEPTABLE RISK: SCIENCE AND THE DETERMINATION OF SAFETY (1976).

10. *E.g.*, Graham & Vaupel, *Value of Life: What Difference Does It Make?* 1 RISK ANALYSIS 89 (1981); LINNEROOTH, THE EVALUATION OF LIFE SAVING: A SURVEY (1975) (Internat. Instit. Applied Systems Anal. Report RR-75-21, Laxenburg, Austria).

is associated with an increased risk of liver angiosarcoma, federal agencies acted quickly to reduce exposure to this chemical, despite the fact that only a handful of cases of liver angiosarcoma had been identified and despite predictions of high cost to industry and consumers. Similar action has not been forthcoming with regard to other environmental agents whose control might save lives at more moderate cost.

- *Asbestos and Seat Belts.* The EPA has recently mandated that all school districts inspect for and, ultimately, remove sources of exposure to friable asbestos in school buildings. One city in Massachusetts has spent $800,000 to remove asbestos, although ambient levels are below the threshold of detection. Parents overwhelmingly support these initiatives and are willing to pay large sums for them. And yet, seat belts and child restraints go unutilized despite the potential for many more lives saved at minimal cost.
- *Sensitive Individuals.* The Clean Air Act requires that standards be set to protect the most sensitive members of the population, including those with chronic health problems. Cost-effectiveness considerations, on the other hand, would suggest that more years of life might be saved at the margin by allocating resources to other environmental measures affecting the population at large.

The list of examples of this kind could be extended indefinitely. The point is that such discrepancies do exist and, moreover, that many of us experience an emotional if not an intellectual response in favor of the cost-ineffective behavior. We are led to ask why, as individuals and as citizens, we are sometimes compelled to resist setting priorities by the criterion of minimum cost per life saved. In particular, we raise the question of whether these apparent anomalies, or violations of the principles of cost-effective resource allocation in the interest of public health, reflect normative concerns that are not captured by aggregated indices such as "expected number of lives saved" or "cost per life saved."[11]

A more fundamental challenge to standard measures of life value has come from psychologists indirectly, in the form of a challenge to the normative axioms of decision theory and its cornerstone, the expected utility model. Experimental psychologists have demonstrated consistent violations of such normative tenets as the sure-thing principle and even

11. It may be hypothesized that these anomalies might be attributable to failure to perform adequate economic analysis prior to decision making. However, there are several instances in which the violations of cost-effective resource allocation persisted despite formal analysis. We hypothesize that many of the residual "inconsistencies" may reflect normative concerns excluded from conventional analyses.

transitivity.[12] These violations also have been found in hypothetical choices involving risk to life.[13]

The fundamental question raised in this paper is to what extent the contextual and psychological attributes of a risky decision have sufficient *normative* status to justify their formal inclusion in methods for valuing risk. Stated in terms of environmental decision making, the question becomes the following: Which psychological and contextual concerns do citizens want environmental decison makers to take into account, and which would they want them to treat as psychological weaknesses, or otherwise unjustifiable perturbations of rational decision making?

For those concerns which are accorded normative status, the subsequent issue then becomes how to modify or extend the standard decision-theoretic and economic models to reflect these concerns. Can one identify primitive carriers of utility whose contribution to the value of risk reduction in a given choice context can be modeled as attributes of a suitable utility function and measured?

2. ECONOMIC AND DECISION-THEORETIC MODELS OF THE CONTEXT-DEPENDENT VALUE OF LIFE SAVING

The allocation criterion of cost per life saved may be viewed as inappropriately simplistic. Using multiattribute theory, decision theorists have developed more sophisticated normative models which may more accurately reflect preferences regarding health risk reduction.

Adjustments for age, quality of life, and time

The number of lives saved is clearly an inadequate measure by which to compare health interventions, if only because lives saved vary by age and quality, and because they may be saved at different points in time. At a minimum, one would want to examine the number of years of life saved. Modern methods of cost-effectiveness analysis in health also adjust for the quality of life-years saved, and apply appropriate discount rates to future years saved.[14] Thus, the present-value, quality-adjusted, year

12. *E.g.*, Slovic & Tversky, *Who Accepts Savage's Axiom?* 19 BEHAVIORAL SCI. 368 (1974); Tversky, *Intransitivity of Preferences*, 76 PSYCHOLOGICAL REV. 31 (1969). For reviews of psychological research on violations of normative choice axioms, *see* Einhorn & Hogarth, *Behavioral Decision Theory: Processes of Judgement and Choice*, 32 ANN. REV. PSYCHOLOGY 53 (1981); Schoemaker, *The Expected Utility Model: Its Variants, Purposes, Evidence and Limitations*, 20 J. ECON. LIT. 529 (1982); Slovic, Fischhoff & Lichtenstein, *Behavioral Decision Theory*, 28 ANN. REV. PSYCHOLOGY 1 (1977).

13. *E.g.*, Tversky & Kahneman, *The Framing of Decisions and the Rationality of Choice*, 211 SCI. 453 (1981).

14. *E.g.*, Weinstein & Stason, HYPERTENSION: A POLICY PERSPECTIVE (1976); Raiffa, Schwartz & Weinstein, *Evaluating Health Effects of Societal Decisions and Programs*, in NAT'L ACAD. SCI., DECISION MAKING IN THE ENVIRONMENTAL PROTECTION AGENCY (1977);

of life saved replaces the life saved as the denominator of the cost-effectiveness ratio. The normative basis for these concerns—age, quality, and timing—is reasonably secure, although not uncontroversial. Unfortunately, most observed cost-inefficiencies in lifesaving activities persist when appropriate adjustments for these factors are made.[15]

Dependence of willingness to pay on mortality probabilities

We have mentioned the recent decision-theoretic work that demonstrates the relation between willingness to pay for reduced mortality probabilities and the pre- and post-intervention probabilities of death. These results depend only on the innocuous assumption that the marginal utility of assets is greater in life than in death. The specific results are as follows:

- For a given decrement in mortality probability, Δp, from an initial level P_0, the willingness to pay for Δp is an increasing function of P_0.[16]
- The equivalent variation for a change in mortality probability from P_0 to P_1 is greater than $1/r$ times the equivalent variation for a change from rP_0 to rP_1, where r is a fraction between zero and one. The same is true of the compensating variations provided that the decision maker is not excessively risk-averse on assets.[17]

The first result says that the value of life saving is greater in people who are closer to death. The second result implies that the aggregate value of life saving in the *ex ante* position relative to some predisposing event is less than the value as assessed *ex post*. The potential applicability of these results to the examples of terminal care versus prevention and of attention to sensitive individuals is straightforward. Whether this effect is strong enough to account for those behaviors is, however, open to question.

3. PSYCHOLOGICAL DETERMINANTS OF ATTITUDES TOWARD HEALTH RISKS

Psychologists and others have discovered that the judged acceptability of health risks is associated with several dimensions not usually considered by economic approaches to risk assessment.[18] A study by Fischhoff and his associates, for example, suggests that risks perceived to be least

Weinstein & Stason, *Foundations of Cost-effectiveness Analysis for Health and Medical Practices*, 296 NEW ENG. J. MED. 716 (1977); Zeckhauser & Shepard, *Where Now for Saving Lives?* 40 LAW AND CONTEMP. PROBS. 5 (1976).

15. Graham & Vaupel, *supra* note 10.

16. Jones-Lee, *supra* note 8. Weinstein, Shepard & Pliskin, *supra* note 8.

17. Weinstein, Shepard & Pliskin, *supra* note 8.

18. *E.g.*, Fischhoff, Slovic, Lichtenstein, Read & Combs, *supra* note 9; Otway, *supra* note 9; Starr, *supra* note 9.

acceptable tended to be borne involuntarily, perceived as uncontrollable, and seen to have delayed effects, among other characteristics.[19] These results may help to explain the asbestos/seat belt anomaly, for example, where the interventions being compared produce effects at opposite extremes of each of these dimensions.

Identifiability of lives saved or lost might also be considered among the possible correlates of willingness to pay for risk reduction. Raiffa, Schwartz, and Weinstein distinguish between identifiability *ex ante* and identifiability *ex post*.[20] Lives lost or saved are *ex ante* identifiable if the identity of the individual(s) saved or lost is known prior to the decision; they are *ex post* identifiable if their survival or death can be attributed to the decision. For example, trapped coal miners and kidney failure patients are identifiable *ex ante* and *ex post,* while victims of vinyl chloride exposure are identifiable *ex post* only. Raiffa, Schwartz, and Weinstein argue that *ex ante* identifiability may lead to a heightened sense of ethical responsibility, and to increased pressure from well-organized groups demanding intervention; *ex post* identifiability, on the other hand, might be associated with a greater sense of accountability on the part of decison-making agents.

A critical issue is raised by this research: Should we grant normative status to attributes such as voluntariness and identifiability, either because their influence is unavoidable or because their influence improves our lives in some way? If they do have normative standing, are they themselves primitive concepts, or do they derive from more elemental primitives? For example, "aversion to delayed effects" might be thought of as deriving from a more fundamental aversion to "anxiety," which is in turn a function of the time until resolution of uncertainty of the probabilities and stakes involved. Also, identifiability *ex post* may relate to a primitive concept of "blame" or "credit" that decreases or increases utility depending upon the probabilistic linkage between decision and outcome.

4. UTILITY PARADOXES AND PSYCHOLOGICAL CONSEQUENCES IN HEALTH RISK DECISIONS

A first step toward answering this question might be guided by experimental research on the psychological processes of decision making. Findings from this research have documented numerous ways in which decisions involving risk violate the prescriptions of the expected utility model. Researchers have advanced several hypotheses to account for these "utility paradoxes." In presenting the following sample of findings from this

19. Fischhoff, Slovic, Lichtenstein, Read & Combs, *supra* note 9.
20. Raiffa, Schwartz & Weinstein, *supra* note 14.

field, we highlight the hypothesis that cost-benefit analyses, decision analyses, and other normative models fail to identify psychological consequences that are important to decision makers. In addition, we discuss ways in which normative models of decision making involving risks to health may be extended to incorporate these consequences.

Probability weights and the certainty effect

Well established within normative decision theory is the notion that an outcome's utility should be weighted by its subjective probability of occurrence, where these probabilities are supposed to be based only on beliefs about the likelihood of events.[21] Psychological research demonstrates, however, that subjective probabilities often appear to reflect not only beliefs about likelihood, but also "preferences," or disproportional weights, given to specific probabilities or distributions.

One of the earliest discoveries of "probability preference" was Edwards' finding that people, given a set of gambles of constant expected value, prefer those offering a 0.5 chance of a payoff.[22] More recently, Kahneman and Tversky interpreted the famous Allais Paradox and responses to similar problems as instances of a "certainty effect," where payoffs obtained with certainty loom disproportionately large relative to outcomes that are uncertain.[23] For example, while a gift of $3000 is preferred to a 0.8 chance at $4000, a 0.25 chance to receive $3000 is less desired than a 0.2 chance at $4000. This response pattern violates utility theory, because the second choice may be derived from the first by reducing both probabilities in the first choice by 0.75.

Kahneman and Tversky also cite Zeckhauser's "Russian roulette" paradox[24] as another example of the certainty effect. Raiffa noted that, when people are compelled to play a hypothetical game of Russian roulette, they typically are willing to pay more to reduce the number of bullets (out of six) from one to zero than from two to one. This choice violated the prescription of normative utility theory, in particular the theorems of Jones-Lee and of Weinstein, Shepard, and Pliskin, cited earlier.[25]

A similar problem has been labeled the "pseudo-certainty effect."[26] As

21. *E.g.*, F. RAMSEY, THE FOUNDATIONS OF MATHEMATICS (1931); de Finetti, *La Precision: Ses Lois Logigue, ses Sources Subjectives*, 7 ANNALES DE L'INSTITUTE POINCARE 1 (1937).

22. Edwards, *Probability-preferences in Gambling*, 66 AM. J. PSYCHOLOGY 349 (1953).

23. Kahneman & Tversky, *Prospect Theory: An Analysis of Decision Under Risk*, 47 ECONOMETRICA 263 (1979).

24. The Russian roulette paradox is discussed in Raiffa, *Preferences for Multiattributed Alternatives* (1969) (Rand Corporation Memorandum RM-5868-DOT/RC, Santa Monica).

25. *See supra* note 8.

26. Tversky & Kahneman, *The Framing of Decisions and the Psychology of Choice*, 211 SCI. 453 (1981).

an example, consider the choice between two disease control programs. Suppose that disease A′ and A″ each kill 1,000 people a year. Program 1 would eradicate disease A′; Program 2 would reduce the mortality from both diseases in half, and in such a way that the would-be victims in the absence of the program cannot be identified. Experiments have shown that people tend to attach greater value to programs like 1 than to programs like 2.[27] Tversky and Kahneman argue that Program 1 evokes the illusion of certainty in that there is one disease from which people can feel completely safe.[28]

Phenomena such as probability preferences and the certainty effect can be modeled within expected utility theory by assuming "probability-weighting" functions, $\pi(p)$, which are not constrained by the consistency rules usually required of probabilities.[29] At least one of these functions is seen by its author to enhance the "rationality" of choice.[30] This claim would be easier to evaluate if we knew what psychological purpose is served by the disproportionate influence of certainty. The proponents of "probability-weighting" functions, however, have not speculated about such a valued psychological consequence.[31]

On the other hand, a number of alternative explanations of the three "certainty effect" paradoxes require no "probability-weighting" function. These include the desire to minimize regret, disappointment, or blame, and, unlike "probability-weighting" schemes, they correspond directly to hypothesized psychological consequences. These are discussed below in the section on reference-point phenomena.

Optimism and pessimism

A second possible revision of the expected utility model is the inclusion of a utility argument in the "probability-weighting" function, $\pi(p,u)$. Descriptively, such a model would seem to be supported by the experimental evidence. For example, research indicates a positive relation between the value of a consequence and its perceived likelihood of occurrence:

27. Slovic, Fischhoff & Lichtenstein, *Response Mode, Framing and Information-processing Effects in Risk Assessment*, in QUESTION FRAMING AND RESPONSE CONSISTENCY 21 (R. Hogarth ed. 1982).

28. *See supra* note 26.

29. *See* Edwards, *The Theory of Decision Making*, 51 PSYCHOLOGICAL BULL. 380 (1954); Handa, *Risk, Probabilities and a New Theory of Cardinal Utility*, 85 J. POL. ECON. 97 (1974); Kahneman & Tversky, *supra* note 13; Karmarkar, *Subjectively Weighted Utility: A Descriptive Extension of the Expected Utility Model*, 21 ORG. BEH. HUM. PERFORM. 61 (1978).

30. Handa, *id.*

31. *But see* N. JORDAN, THEMES IN SPECULATIVE PSYCHOLOGY (1968) *cited by* Vlek & Wagenaar, *Judgment and Decision Under Uncertainty*, in HANDBOOK OF PSYCHONOMICS, VOL. II at 253 (J. Michon, E. Eijkovan and L. Deklerk eds. 1979).

the so-called "wishful thinking" effect.[32] In defending this phenomenon as normative, Akerlof and Dickens argue that the anticipation of good outcomes and the fear of bad ones are psychological consequences which should be included explicitly in the outcome set.[33] Thus, as normative concepts, optimism and pessimism may be modeled more appropriately as arguments of utility rather than as modifications of probability, provided that the normative probabilities do not also reflect these effects.

Finally, in an interesting link to the research on risk dimensions cited above, experiments indicate that optimism in estimating risks is less likely to occur if outcomes are seen as entirely uncontrollable.[34] An appealing hypothesis, then, is that uncontrollable health risks are less acceptable because they deprive us of the emotional comfort afforded by an unrealistically rosy outlook.

The effect of risk taking on judgments of risk

The fundamental tenet of normative decision theory is that choices and actions should follow from beliefs and values. Behavioral research has shown, however, that often the reverse is true. Bem's self-perception theory and Festinger's theory of cognitive dissonance highlight the role of behavior in determining beliefs and values.[35] For example, Festinger's theory would predict that Mr. Jones believes there to be no association between smoking and lung cancer *because* he smokes, and not the other way around. To believe otherwise would cause him to hold dissonant cognitions about his beliefs, values, behavior, and image of himself as a rational person. To reduce this dissonance, he may find it easier to change his beliefs or values than to alter his behavior or self image. Thus, descriptive models might account for the psychological consequence of dissonance reduction by allowing a probability-weighting function to include current behavior as one of its arguments, $\pi(p, \text{behavior})$.

The implications of cognitive dissonance for modeling health policy decisions were explored by Akerlof and Dickens.[36] These authors posit

32. Irwin, *Stated Expectations as Functions of Probability and Desirability of Outcomes*, 21 J. PERSONALITY 329 (1953); Marks, *The Effect of Probability, Desirability and "Privilege" on the Stated Expectations of Children*, 19 J. PERSONALITY 332 (1952); Slovic, *Value as a Determiner of Subjective Probability*, 7 IEEE TRANS. HUM. FACT. ELECT. 22 (1966); *see also* W. LEE, DECISION THEORY AND HUMAN BEHAVIOR (1971).

33. *See*, Akerlof & Dickens, *The Economic Consequences of Cognitive Dissonance*, 72 AM. ECON. REV. 307 (1982).

34. Cohen & Hansel, *Preferences for Different Combinations of Chance and Gambling*, 183 NATURE 841 (1959).

35. D. BEM, BELIEFS, ATTITUDES AND HUMAN AFFAIRS (1970); L. FESTINGER, A THEORY OF COGNITIVE DISSONANCE (1957).

36. *See supra* note 33.

that workers attach a cost to their perceived probability, q*, of an accident. Workers select jobs, decide whether to adopt safety protection measures, *and choose q**, in such a way as to maximize the difference between wages, and the combined costs of safety protection measures and what Akerlof and Dickens call "fear." Their concept of fear (defined to be proportional to q*/q, i.e., the ratio of perceived to actual risk) incorporates both fear per se and the psychological stress produced by cognitive dissonance. In order to justify working where they do, individuals alter their perceived risks to minimize fear and dissonance. Akerlof and Dickens do not explicitly discuss the normative aspects of these factors in the workers' utility functions, but by including this term in the maximand for social welfare optimization, they implicitly give it normative status.

The approach taken by Akerlof and Dickens differs from that of Kleindorfer and Kunreuther, in which consumer misperceptions of "true" risks of products are viewed simply as errors.[37] The latter authors distinguish "felicity in error" (i.e., the *ex ante* utility of consumers who have misperceptions) from "felicity in fact" (i.e., their *ex ante* utilities as if they perceived the probabilities correctly), but they seem to give normative status only to the latter.

It is an open question whether "dissonance" or "fear" ought to be considered among the socially legitimate criteria for decision making. If long-time residents near a coal plant alter their judgments of the risks of particulate pollution to minimize dissonance, should environmental decision makers acknowledge that the residents' utility is a function of both their actual and judged risks? Are individual decisions to smoke cigarettes or not to wear seat belts rendered normatively less irrational because decisions to do otherwise would increase dissonance? Perhaps the findings of Fischhoff and his associates concerning attitudes toward voluntary risks can be traced to this phenomenon.

Reference-point phenomena

Utility theorists are dismayed by the evidence that the utility assigned to an outcome can be influenced by the lottery context in which the outcome is embedded. For example, relative utilities for health states in cancer patients have been shown to vary systematically, depending on whether death is used as the lower anchor in the standard gamble assessment procedure.[38] Thus, presenting an outcome in the context of a

37. KLEINDORFER AND KUNREUTHER, DESCRIPTIVE AND PRESCRIPTIVE ASPECTS OF HEALTH AND SAFETY REGULATION (1978) (Wharton School of Management Discussion Paper 78-09-02, Philadelphia).

38. Llewellyn-Thomas, Sutherland, Tibshirani, Ciampi, Till and Boyd, *Health Utility Assessment Using von Neumann and Morgenstern's Standard Gamble: Fundamental Assumptions*, 2 MEDICAL DECISION MAKING 449 (1983).

lottery may cause it to be evaluated relative to other possible outcomes, leading to the anticipation of disappointment or elation.[39] The accident victim, whose life is saved, but with the loss of both legs, might feel worse if he had been faced with a 90 percent chance of dying than if he had faced an 80 percent chance of his avoiding permanent disability altogether. Physicians are very familiar with the concepts of disappointment and elation.

If the context includes an actual choice among uncertain alternatives, then the reference point for valuing each possible outcome may derive from what would (or might) have happened under the choice not taken. Lee provides empirical evidence for this phenomenon,[40] and Bell, and Loomes and Sugden have modeled it as a normative carrier of utility.[41] In these formulations, "gratification" (or, for Loomes and Sugden, "rejoicing") is an increasing, concave function of the value difference between the outcome that would have occurred under the option not chosen and the outcome actually obtained; "regret" is the term applied in the negative domain (i.e., following a "wrong" decision). These authors hypothesize that regret may play a role in choice paradoxes such as the certainty effect.[42] For example, Bell shows that the certainty effect may be modeled by including regret as an argument in the utility function.[43]

While the regret model is limited to comparisons in which the "would-have-been" outcome is known with certainty, our related concept of "blame" generalizes to the case of *ex post* uncertainty regarding the unchosen option and seems especially apt in social contexts such as environmental decision making.[44]

Blame in health risk decision making is associated with an adverse outcome (e.g., death), and is directly related to the degree to which the bad outcome is attributable to the decision. Its opposite, credit, is associated with a favorable outcome (e.g., survival), and is defined in an analogous way.[45] We illustrate the concepts by applying them to two health risk decision phenomena.

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39. *See* BELL, DISAPPOINTMENT IN DECISION MAKING UNDER UNCERTAINTY (1982) (Harvard Business School Working Paper 82-18, Allston, MA).

40. W. LEE, *supra* note 32.

41. Bell, *Regret in Decision Making Under Uncertainty*, 30 OPERATIONS RESEARCH 961 (1982); Loomes & Sugden, *Regret Theory: An Alternative Theory of Choice Under Uncertainty*, 92 THE ECON. J. 805 (1982).

42. *See, e.g.*, Morrison, *On the Consistency of Preferences in Allais' Paradox*, 12 BEHAVIORAL SCI. 373 (1967).

43. *See supra* note 41.

44. Graham, *Some Explanations for Disparaties in Lifesaving Investments*, 1 POL'Y. STUD. R. 592 (1982).

45. More formally, suppose there are J possible outcomes of A', some subset (J_1) of which results in D and some subset ($J-J_1$) of which results in S. Let π_j be the probability of outcome j under A'. Let p_j ($1 \leq j \leq J_1$) denote the probability of S and A" given that A' resulted in outcome j, and let q_j

(1) *Pseudocertainty effect.* Consider the choice between two disease control programs as presented earlier. Recall that Program 1 would eradicate disease A′, while Program 2 would reduce the mortality from both diseases in half, and in such a way that the would-be victims in the absence of the program cannot be identified. Both programs would save 1,000 lives.

With either Program 1 or 2, the potential credit for lives saved is small (relative to the status quo) because the probability of death is small, and because the would-be victims cannot be identified *ex post*. The critical difference lies in the blame for failing to adopt the programs. By choosing Program 2 over Program 1, 500 deaths (from disease A′) would be attributed with certainty to failure to adopt Program 1. By choosing Program 1 over Program 2, however, the 1,000 deaths from disease A″ would be attributed with only 50 percent probability to the decision. If the prospect of full blame for 500 deaths is perceived as greater than the blame for being 50 percent responsible for each of 1,000 deaths, then considerations of blame would make Program 1 a more attractive use of resources.[46]

Real analogies of this effect abound. Society tends to be more eager to eliminate rare diseases that are mostly attributable to specific environmental agents than to reduce mortality from more prevalent diseases by similar margins. Thus, regulations to prevent mesothelioma due to asbestos exposure and liver angiosarcoma due to vinyl chloride exposure are enthusiastically embraced, while air pollution controls that would reduce the incidence of chronic lung disease by fractional amounts are greeted with less enthusiasm. The blame for lives lost in the latter cases would be negligible; the lives lost in the former cases would be directly linked to failure to act.

(2) *Sensitive individuals.* The emphasis on protecting sensitive individuals (i.e., those with high excess risk from toxic environmental ex-

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$(J_1<j\leq J)$ denote the probability of D under A″ given that A′ resulted in outcome j. The net expected blame for the choice of A' over A'' is defined as

$$NEB\,(A';A'') = \sum_{j=1}^{J} \pi_j\,[\delta_j B\,(p_j) - (1-\delta_j)C(q_j)],$$

where $\delta_j = 1$ if $j\leq J_1$ and $\delta_j = 0$ if $j>J_1$.

The net expected blame is closely related to the formal notion of regret, which is defined as a function of the difference between the outcome that would have occurred. Thus, regret as defined by Bell and by Loomes and Sugden, *supra* note 15, is both more general (allowing for a continuum of outcomes rather than a dichotomy) and more restrictive (assuming a one-to-one, deterministic correspondence between outcomes under A' and outcomes under A'').

46. This hypothesis may be challenged on the grounds that the pseudocertainty effect has been found experimentally even when subjects are told that the two diseases A′ and A″ are indistinguishable, thus apparently erasing the difference in blame between the two programs, *supra* note 27. It is not clear, however, that the mere statement about indistinguishability carried sufficient force to eliminate the prospect that the cause of death would remain unknown to all parties.

posures) may be traced to credit-blame concerns. Given a choice between reducing the mortality probability from 0.3 to 0.2 for 10 sensitive persons or from 0.01 to 0.009 for 1,000 average persons, the former would be favored by credit-blame considerations. In the former case, each of three deaths would be attributed with probability $1/3$ to failure to act, while in the latter case, each of 10 deaths would be attributed with probability $1/10$ to failure to act.[47]

Alternative explanations exist for the preference phenomena illustrated above. Of these, the probability-weighting function noted earlier has received empirical support as one factor underlying the "certainty effect" and related experimental findings.[48] Despite its intuitive appeal, therefore, credit-blame theory must be put to a direct empirical test before its relevance to actual choice behavior is clear.

Time to resolution of uncertainty

Little experimental research has examined how decision making is affected by the time needed to resolve uncertainty. Yet such an effect seems plausible. For example, patients demand diagnostic tests even when no treatment can improve their conditions, just to determine how healthy they are. Gambles that would be acceptable if resolved instantly may be unacceptable if resolution is delayed, or *vice versa*.

Two factors may contribute to the preference for immediate resolution. One is that subsequent decisions may be made under less uncertainty, thus improving expected outcomes.[49] For example, in planning one's estate it is valuable to know whether one has a remaining life expectancy of 5 years or 25 years, rather than being forced to act subject to a 50-50 gamble between those possibilities. Thus, a patient in such a situation may elect to have a risky diagnostic procedure in order to resolve the matter once and for all, even if it cannot lead to an improved health outcome. This aspect of time to resolution can be modeled within expected utility theory, although this is rarely done in practice.

Another factor contributing to preference for immediate resolution is anxiety. The state of mind of not knowing what is going to happen (or has already happened) may be sufficiently unpleasant that other carriers of utility (e.g., health, money) may be sacrificed to reduce it. Thus, freedom from anxiety may, itself, be viewed as a legitimate attribute in

47. Convexity implies that $10B(1/10) < 3B(1/3)$, and that $991C(1/991) < 8C(1/8)$. The stated result follows by dividing both sides of both inequalities by 10.

48. Kahneman and Tversky, *supra* note 23, have argued that the probability-weighting explanation of the certainty effect is supported by the observation that the effect holds in both gain and loss domains.

49. Spence & Zechhauser, *The Effect of the Timing of Consumption Decisions and the Resolution of Lotteries on the Choice of Lotteries*, 40 ECONOMETRICA 401 (1972).

a utility function. (The opposite of anxiety—anticipation—may also play a role in more pleasant situations and may explain why many expectant parents would pay not to know the sex of their offspring in advance.)

Much of the research on risk attitudes cited earlier indicates that anxiety may play an important role in environmental decision making. Otway, for example, reported that the attitudes of those opposing nuclear energy were dominated not by environmental risks but by a psychological factor termed "anxiety."[50] (Involuntary exposure to a hazardous substance stands in contrast to the decision to live near a coal plant, where dissonance may outweigh anxiety in the utility function.) As with blame and dissonance, admittedly, there is no empirical evidence that anxiety is measurable, or that it would satisfy empirically the properties of an argument in a well-behaved utility function. However, we do advance the hypothesis that anxiety may account for certain preference patterns involving health risks, and, moreover, that people really would want anxiety to be recognized as a legitimate contributor to their expected utility.

5. CONCLUSIONS

We have proposed that a broader view of preferences regarding health risks be taken than is normally captured within prescriptive approaches such as decision theory or benefit-cost analysis. We hypothesize that certain psychological phenomena, such as dissonance, blame, and anxiety may (1) account for seemingly irrational choices and preferences in health risk decisions and (2) have legitimate standing in prescriptive approaches to such decisions.

At the same time, we acknowledge the formidable empirical task of documenting and measuring these preferences. Perhaps it would be impractical to attempt to develop a general prescriptive model that includes all of these variables. An alternative approach would be to rely on revealed preferences, analogous to implicit willingness to pay, while treating as covariates such characteristics of the decision as the voluntariness of the risk, or the degree of *ex post* identifiability of lives lost or saved. Our view is that both of these approaches, based on explicit and implicit statements of preference, should be pursued. Both would advance our current crude understanding of the value of life saving.

This paper has focused on *preferences*. We have not discussed perception of *probabilities* as a determinant of choice in health decisions, except insofar as it relates to aspects of preference (e.g., dissonance reduction). It is conceivable that much of the "irrational" behavior in risky decisions can be explained by failures of the human mind to perceive probabilities correctly. To the extent that this is true, testing hypotheses

50. Otway, *supra* note 9.

about allegedly excluded carriers of utility may prove to be less important than sharpening our abilities to estimate and understand risks.

It is important to note also that a number of psychologists have doubts about the external validity of some of the research findings cited here.[51] They claim that the experimental methods typical of this area of research are characterized by homogeneous subject populations (typically college sophomores) and static, contrived experimental tasks (of which the Russian roulette problem may be an example) that are unrepresentative of "real world" decision-making environments. While it is unlikely that such criticism invalidates all of the choice behavior findings discussed here, we join those who call for the testing of these findings in non-laboratory settings.

Having identified dissonance, credit and blame, and anxiety as attributes of utility that may have explanatory power in health risk decision making, we ask now whether we *want* our decisions to reflect these concerns. Are we really willing to forfeit dollars or lives (on average) to reduce blame or increase credit? Our behavior suggests that we are willing to do so.[52] People do not change their minds about choices like the hypothetical Russian roulette game even when their "error" is explained to them. In our view, it is an open question whether the affective responses to such choices are less "rational" than the responses suggested by theories that focus only on tangible consequences of decisions. We argue, however, that until the psychological consequences underlying utility paradoxes are identified, the question of rationality cannot be addressed effectively.

Finally, we raise in this context a question that has concerned economists for centuries. To the extent that the psychological concerns described here could be manipulated so that people are no longer concerned about blame, dissonance, or anxiety, either consciously or subconsciously, would these people be better off as a result? This is, essentially, the question that underlies debates about merit wants and about whether preferences are endogenous or exogenous: Are some sets of preferences normatively better than others, or must we accept preferences as given, regardless of how they come about? Judgments about the value of health education and the use of the media to "inform" citizens about environmental risks may hinge on the resolution of these questions.

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51. *See, e.g.*, Edwards, *Human Cognitive Capabilities, Representativeness and the Ground Rules for Research*, in ANALYZING AND AIDING DECISION PROCESSES (P. Humphreys, O. Svenson and A. Vari eds., in press); HAMMOND, THE INTEGRATION OF RESEARCH IN JUDGMENT AND DECISION MAKING (1980) (Center for Research on Judgment and Policy Report 226, Univ. of Colorado, Boulder).

52. For example, in a treatment of the decision to seed hurricanes, Howard, Matheson and North argue that a prescriptive analysis of the program should include the degree of "responsibility" attributed to the government by hurricane victims, *The Decision to Seed Hurricanes*, 176 SCI. 1191 (1972).