RESPONSE

SAVING LIVES: BENEFIT-COST ANALYSIS AND DISTRIBUTION

JAMES K. HAMMITT[†]

In response to John D. Graham, *Saving Lives Through Administrative Law and Economics*, 157 U. PA. L. REV. 395 (2008).

When does the creation of benefits to some people justify the imposition of harms on others? This is a central question for public policy. Despite rhetorical claims of win-win solutions, all policies impose harms on some people, at least in the sense of opportunity harms—forgoing an alternative policy that would provide greater benefits to these individuals. An increasingly common method for answering this question is to use benefit-cost analysis (BCA) to compare the monetary value of the gains to those who benefit to the monetary value of the losses to those who are harmed. If the aggregate value of the gains exceeds that of the harms, the policy is said to yield positive net benefits relative to the status quo and to constitute an improvement in social welfare.

On what basis does the existence of positive net benefits justify concluding that the policy improves social welfare? There are at least two possible answers: One is that the existence of positive net benefits implies that the policy satisfies the Kaldor-Hicks (KH) compensation test and hence provides a potential Pareto improvement, or, in other words, a change that could in principle be converted to a Pareto improvement by payment of monetary compensation from those who benefit to those who are harmed by the change.[1] Another is to define

[†] Professor of Economics and Decision Sciences, Center for Risk Analysis, Harvard University.

[1] As noted by Graham, it is more reasonable to evaluate transfers and Pareto im-

social welfare as the sum of individuals' utilities and interpret net benefits as an approximation of the sum of gains and losses of utility among the population, an approximation that would be exact if the incremental or marginal utility of money were equal among all members of the society. Under the conventional economic assumption that it is not possible to reliably compare changes in utility across persons (e.g., to determine who suffers more from the same disease), some approximation of utility is required, and the assumption of equal marginal utilities cannot be tested.

One concern about BCA is that it may systematically favor the rich over the poor. This concern follows because the monetary values of benefits and harms are likely to be larger in absolute value for those with greater wealth and who are likely to have fewer or less compelling demands on their wealth. If the marginal utility of money decreases with wealth, the monetary value of the same increment in utility will be larger for the rich than for the poor, and thus policies that increase utility for the rich and decrease it by the same amount for the poor may have positive net benefits.

In his comprehensive and insightful discussion of the value of using BCA to evaluate lifesaving regulations, John Graham proposes to mitigate this bias toward rich over poor by imposing a supplemental KH test including only the benefits and costs to the worst-off group in society, provisionally identified as households below the poverty line.[2] A policy that satisfies both KH tests—for the full population and for the most disadvantaged group—would be presumed to be socially beneficial and merit adoption, while a policy that failed either KH test should not be adopted. Graham advocates a "soft" use of the KH test as a decision criterion, under which considerations of equity, nonquantified benefits and costs, and other factors may supersede calculated net benefits.[3] Presumably, he would apply this soft interpretation to both full-population and most-disadvantaged-group KH tests (though the need to adjust for equity would be partially obviated by consideration of the second KH test).

Quantitative evaluation and incorporation of distributional consequences in regulatory evaluation are important advances. Whether Graham's proposed supplemental KH test is the best method for in-

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provement over a portfolio of policies rather than for each individually. *See* John D. Graham, *Saving Lives Through Administrative Law and Economics*, 157 U. PA. L. REV. 395, 414-19 (2008).

[2] *See* Graham, *supra* note 1, at 516-24.

[3] *Id.* at 433-34.

corporating these consequences in the evaluation may be debated, but it represents one reasonable and practical approach. As Graham notes, there are many dimensions of population heterogeneity that may be viewed as relevant to equity, and evaluating differential effects across all these dimensions would be burdensome for analysts and potentially overwhelming for decision makers, who would face the question of how to aggregate the voluminous results.[4]

Graham's second KH test could be viewed as an inadequate evaluation of equity, as it provides no information about the differential effects of a proposed rule on groups other than the most disadvantaged (or about differential effects among subgroups of the most disadvantaged, if any). But Yew-Kwang Ng's proposal to apply a KH test to every income group[5] seems far too demanding, as there are surely cases in which benefits to some groups may justify harms to others, even if the pattern of effects is regressive over parts of the income distribution (e.g., if benefits to a high-income group are very large compared with the harms to a lower-income group). Matthew Adler's proposed "probabilistic population profile analysis" using an explicit social-welfare function[6] is promising, but the plan requires more work to determine if it is feasible and how sensitive results are to alternative assumptions about the exact shape of the utility and social-welfare functions.

One advantage of incorporating an explicit distributional test in regulatory evaluation is that it should encourage regulators to identify ways to modify rules to make their effects more progressive or, at least, to mitigate harms to the most disadvantaged groups. Another is that it may facilitate greater honesty in evaluating the monetary values of benefits and harms to subpopulations. In current practice, it is conventional to use the same monetary value of mortality risk (the value per statistical life, or VSL) for all individuals, regardless of wealth, income, age, and other factors.[7] Although it is clear from both eco-

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[4] *Id.* at 517-18.

[5] *See* Yew-Kwang Ng, *Quasi-Pareto Social Improvements*, 74 AM. ECON. REV. 1033, 1034 (1984).

[6] *See* Matthew D. Adler, *Risk Equity: A New Proposal*, 32 HARV. ENVTL. L. REV. 1, pt. II (2008).

[7] A U.S. Environmental Protection Agency Science Advisory Board report concluded that VSL should not be adjusted for cross-sectional differences in income "because of the sensitivity of making such distinctions." ENVTL. ECON. ADVISORY COMM., U.S. EPA, AN SAB REPORT ON EPA'S WHITE PAPER *VALUING THE BENEFITS OF FATAL CANCER RISK REDUCTION* 5 (2000), *available at* http://yosemite.epa.gov/sab/sabproduct.nsf/webReportsbyYearBOARD!OpenView (click on "2000," then on report title). A more recent SAB report found that VSL may vary with age and health

nomic theory and abundant empirical evidence that VSL increases with income,[8] estimates of the benefits of lifesaving rules rarely, if ever, account for contemporaneous differences in VSL because of the perceived inequity of using a smaller VSL for individuals with lower incomes.[9]

This reluctance to recognize differences in valuation among individuals can lead to errors in policy evaluation and choice. Consider a simple example. Let society be composed of two equally populous subgroups, *H* (high-income individuals) and *L* (low-income individuals). Individuals in *H* have a VSL of $6 million, and those in *L* have a VSL of $4 million.

Consider two proposed policies: Compared with the status quo, policy *A* reduces current mortality risk to everyone in *L* by 5/100,000. Policy *B* reduces current mortality risk to everyone in *H* by 4/100,000. The cost of each policy is $115 to each member of society. Note that if these are the only possible choices, the status quo, policy *A*, and policy *B* are all Pareto efficient.

The benefits of policy *A* are $200 for each member of *L*,[10] and zero for each member of *H*. Subtracting the costs of $115 yields net benefits of $85 for each member of *L* and -$115 for each member of *H*, or -$15 per capita for the population. The net benefits of policy *A* are negative, and it is not possible for those who gain (members of *L*) to compensate those who are harmed (members of *H*) to make adoption of policy *A* with compensation a Pareto improvement.

For policy *B*, the benefits are $240 per capita in *H* and zero in *L*. Net benefits per capita are $125 in *H*, -$115 in *L*, and $5 in the society. Because net benefits are positive, those who gain (*H*) can compensate those who are harmed (*L*) to create a Pareto improvement (e.g., if each member of *H* pays $120 and each member of *L* receives $120,

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status and that the EPA may wish to incorporate this variation in its analyses, but it concluded that existing empirical estimates do not provide sufficient information to make such adjustments. *See* SCI. ADVISORY BD., U.S. EPA, SAB ADVISORY ON EPA'S *ISSUES IN VALUING MORTALITY RISK REDUCTION*, at D-10 (2007).

[8] *See, e.g.*, James K. Hammitt, *Valuing Mortality Risk: Theory and Practice*, 34 ENVTL. SCI. & TECH. 1396, 1398 tbl.1 (2000); 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, 36-43 (2003).

[9] In contrast, increases in VSL over time associated with rising average incomes are often incorporated.

[10] For a small risk reduction, willingness to pay is nearly equal to the product of VSL and the risk reduction. For example, $4 million multiplied by 5/100,000 equals $200.

everyone obtains a net benefit of $5 from adoption of policy *B* with compensation).

Evaluating these policies using a common VSL for the population yields erroneous results. Using the population-average VSL ($5 million), the calculated benefits of policy *A* are $250 for each member of *L* and zero for each member of *H*, yielding calculated net social benefits of $10 per capita. The calculated benefits of policy *B* are $200 for each member of *H* and zero for each member of *L*, yielding calculated net benefits of -$15 per capita. From these results, a decision maker might conclude that policy *A* is socially beneficial and policy *B* is not, even though it is possible to arrange compensation payments such that policy *B* yields a Pareto improvement but not possible to do the same for policy *A*.

For reasons of equity, society may wish to adopt policy *A*, yielding net benefits of $85 for each member of *L* at the cost of net losses of $115 for each member of *H*. Note, however, that greater benefits to *L* could be provided at the same cost to *H* by simply transferring $115 per capita from *H* to *L*, yielding net benefits of $115 to each member of *L*.[11]

Clearly, members of *L* do not benefit from a regulation that requires them to spend more for a lifesaving intervention than they value it. For example, if the beneficiaries of each policy were required to pay its full costs, members of *L* would not wish to pay $230 for policy *A*, which yields benefits that they value at only $200, though members of *H* would be willing to pay $230 for policy *B*, which yields benefits that they value at $240. If members of *H* wished to assist members of *L* by paying the full cost of policy *A*, they could provide greater benefit to members of *L* by transferring $230 per capita than by paying for the lifesaving policy that is valued at only $200 per capita. In short, if the intent is to provide the most benefit as evaluated by the beneficiaries themselves, nothing is gained and something may be lost by valuing lifesaving benefits using a different VSL than the beneficiaries themselves would apply. Policy evaluation and choice should be improved by taking account of distributional and equity concerns directly, rather than by using incorrect valuations of lifesaving benefits in an attempt to incorporate equity considerations as is commonplace in current practice.

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[11] This argument assumes that cost-free transfers are possible. *See* ARTHUR M. OKUN, BROOKINGS INST., EQUALITY AND EFFICIENCY: THE BIG TRADEOFF, ch.4 (1975) (discussing the cost and acceptability of transfers).

As Graham notes, money is used as the metric for comparison across individuals in BCA, though other valued goods could be used as an alternative metric.[12] Given the assumption that changes in utility cannot be measured and compared directly across individuals, it is necessary to adopt some standard or proxy metric for comparison. A natural alternative to using money is to use a measure of health benefit, such as quality-adjusted life years (QALYs). In cost-effectiveness analysis, health benefits are measured in QALYs, costs and other effects are measured in dollars, and it is assumed that there is a constant marginal rate of tradeoff in society between dollars and QALYs. Alternatively, it is possible to measure both health effects and monetary costs in units of health benefit and to analyze policies using a measure of net health benefit.[13] Using a health rather than a monetary metric might come closer to the goal of comparing incremental utility across individuals that is required for the second justification of BCA proposed above: that it is a method for aggregating effects on utility across the entire population.[14]

In general, when the rate of tradeoff between metrics differs in the population, the choice of metric can affect the conclusion about which of a set of Pareto-efficient policies is most preferred. The justification for using a monetary metric is that money can be transferred among affected individuals at low or modest cost (e.g., through changes in the tax code and income-support programs), but other possible metrics are more difficult or costly to transfer. Hence, if net monetary benefits are positive, it is conceivable that a set of transfers could be adopted such that the change would constitute a Pareto improvement, but if net health benefits or net benefits using some other metric were positive, it might not be possible to construct a set of transfers that would make everyone better off.[15]

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[12] *See* Graham, *supra* note 1, at 413.

[13] *See* Aaron A. Stinnett & John Mullahy, *Net Health Benefits: A New Framework for the Analysis of Uncertainty in Cost-Effectiveness Analysis*, 18 MED. DECISION MAKING S68, S78-79 (1998) (assuming a constant rate of substitution between dollars and QALYs).

[14] See *supra* text accompanying note 1.

[15] In the current example, if mortality risk were used as the metric, policy *A* would be preferred to the status quo and policy *B* would not. Define net health benefits as equal to the risk reduction minus monetary costs and measure mortality risk in units of micromorts. A micromort is a 1/1 million risk-change. *See* Ronald A. Howard, *On Fates Comparable to Death*, 30 MGMT. SCI. 407, 408-09 (1984). Note that an individual's WTP per micromort equals her VSL divided by 1 million. Policy *A* provides a health benefit of 50 micromorts to each member of *L*. The cost of $115 is valued as 28.75 micromorts ($115 / $4 per micromort) for members of *L* and as 19.17 micromorts ($115 / $6 per micromort) for members of *H*. Net health benefits are 21.25 (50 – 28.75) micromorts

There is some ambiguity about whether BCA is best viewed as a positive (i.e., descriptive) or normative (i.e., prescriptive) exercise. This ambiguity reflects the existence of persistent differences between experts and lay members of the public in evaluation of mortality and other risks. Although risk experts often focus their attention on the expected number of fatalities and similar aggregate measures, members of the public may focus more on other attributes of a risk, such as the degree to which it is dreaded, uncertain, familiar, voluntary, controllable, natural, or man-made.[16]

To some extent, expert evaluations are incomplete, as individuals may care about attributes of the risk beyond the probability of fatality. For example, instantaneous death from traumatic injury in a motor vehicle crash when one is the driver differs from death in an airliner crash when one is a passenger, or from lingering death caused by chronic, degenerative diseases such as lung cancer or Alzheimer's disease that may or may not have been caused by the individual's behavior. Analysts often value changes in risk of these different hazards using the same VSL, though this is primarily because there do not exist reliable estimates of how an individual's willingness to pay (WTP) to reduce mortality risk differs among these situations.[17]

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for each member of *L* and -19.17 micromorts for each member of *H*. If risk reduction could be transferred between individuals without loss, members of *L* could compensate members of *H* by transferring between 19.17 and 21.25 micromorts per capita so that all members of the society would prefer adoption of policy *A* plus compensation (in mortality risk) to the status quo. Analogously, policy *B* provides 40 micromorts to each member of *H*, for a net health benefit of 20.83 micromorts to each member of *H* and -28.75 micromorts to each member of *L*. Aggregate net health benefits for the society are negative, and it is not possible for those who benefit (in *H*) to compensate those who are harmed (in *L*) so that everyone prefers adoption of policy *B* plus transfer of mortality risk to the status quo.

[16] *See, e.g.*, PAUL SLOVIC, THE PERCEPTION OF RISK (2000) (analyzing the similarities and differences in risk perception between experts and lay people); CASS R. SUNSTEIN, RISK AND REASON, ch.3 (2002) (same); Paul Slovic, *Perception of Risk*, 236 SCIENCE 280 (1987) (same). For discussion of the normative significance of expert/lay differences in evaluation, see James K. Hammitt, *Evaluating Risk Communication: In Search of a Gold Standard*, *in* FORESIGHT AND PRECAUTION 15, 15-19 (M.P. Cottam et al. eds., 2000).

[17] A few studies have elicited individual preferences about risks to themselves (rather than to a community). Wesley Magat et al. estimated that the median survey respondent values risk of fatal lymphoma and motor-vehicle-crash fatality equally. Wesley A. Magat et al., *A Reference Lottery Metric for Valuing Health*, 42 MGMT. SCI. 1118, 1129 (1996). George Van Houtven et al. estimated that respondents value fatal cancer risk between two and three times as much as motor-vehicle crash fatality (the differential is smaller for cancers with longer latency periods). George Van Houtven et al., *Cancer Premiums and Latency Effects: A Risk Tradeoff Approach for Valuing Reductions in Fatal Cancer Risks*, 36 J. RISK & UNCERTAINTY 179, 193 (2008). James Hammitt and Jin-Tan Liu found that respondents value risk of fatal cancers about one-third more than

On the other hand, lay evaluations are sometimes clearly erroneous. Perhaps the clearest example is when people view logically equivalent situations differently depending on the way in which the risk is framed (or described). In a famous example involving a hypothetical epidemic putting 600 people at risk, 72% of survey respondents prefer (a) saving 200 lives for sure to (b) a one-third chance of saving 600 lives and a two-thirds chance of saving no lives.[18] When another sample was presented with the logically equivalent choice between (c) 400 deaths for sure and (d) a two-thirds chance of 600 deaths and a one-third chance of no deaths, 78% chose option (d).[19] Since the alternative presentations are logically equivalent, there appears to be no justification for maintaining inconsistent preferences. It seems reasonable to believe that individuals would wish to be made aware of cases in which their judgments reflect framing effects and would wish to limit their susceptibility to these, just as many individuals discount information provided by advertising and appear to resent advertising's attempts to manipulate their actions.

A less obvious example of seemingly erroneous evaluations is when respondents to stated-preference surveys indicate that their maximum WTP to reduce mortality risk by different magnitudes differs much less than in proportion to the risk change. Most stated-preference surveys that test for differences in WTP for different risk reductions find that WTP is less than proportional to the risk change.[20] For example, Jones-Lee et al. asked respondents their maximum WTP to reduce their risk of dying on a single bus trip from 8/100,000 to 4/100,000 and also from 8/100,000 to 1/100,000.[21] Forty-two percent of respondents provided the same non-zero value for both questions (the median response for both questions was £50),[22] which implies that they valued the initial risk reduction (from 8/100,000 to 4/100,000) at some positive value, but valued the addi-

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noncancer diseases with identical symptoms and prognosis, and that they value risk of lung disease from industrial air pollution twice as highly as liver disease from drinking water contamination. James K. Hammitt & Jin-Tan Liu, *Effects of Disease Type and Latency on the Value of Mortality Risk*, 28 J. RISK & UNCERTAINTY 73, 73 (2004).

[18] Amos Tversky & Daniel Kahneman, *Rational Choice and the Framing of Decisions*, 59 J. BUS. S251, S260 (1986).

[19] *Id.*

[20] *See* James K. Hammitt & John D. Graham, *Willingness to Pay for Health Protection: Inadequate Sensitivity to Probability?*, 18 J. RISK & UNCERTAINTY 33, 36-40 (1999).

[21] *See* M.W. Jones-Lee et al., *The Value of Safety: Results of a National Sample Survey*, 95 ECON. J. 49 (1985).

[22] *Id.* at 65 and calculations based on tbl.4.

tional risk reduction (from 4/100,000 to 1/100,000) at zero. Though economic theory suggests that WTP for risk reduction should increase less than proportionately to the magnitude of the risk reduction, for the small risks and payment amounts in question, WTP is expected to be nearly proportional to the risk reduction.[23] The sharp drop in incremental WTP for incremental risk reduction found by the Jones-Lee et al. study[24] is implausible and suggests some sort of cognitive error.[25]

Another example of how public preferences differ from expert evaluations is the difference between estimates of WTP for a risk reduction or other benefit and willingness to accept compensation (WTA) to forgo the risk reduction or other benefit (or to accept a risk increase of identical magnitude). As explained by Graham, the difference between estimates of these quantities is often much larger than is consistent with economic theory and may represent some sort of cognitive foible.[26]

The justification for BCA that rests on the KH test is predicated on "consumer sovereignty,"[27] the notion that each individual is the best judge of changes in her own well-being. In this framework, BCA may be viewed as a positive (i.e., descriptive) exercise—it is designed to determine whether monetary transfers could be arranged so that every member of a society that adopted a lifesaving rule together with these transfers would find herself better off (or at least no worse off) than without the change. In this framework, BCA implements an extremely populist conception of public policy—the views of every member of society about her own interests contribute to the evaluation. But if BCA is conducted in a way that substitutes experts' judgments about preferences for those of the affected individuals, BCA

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[23] *See* Hammitt & Graham, *supra* note 20, at 34-36.

[24] *See* Jones-Lee et al., *supra* note 21, at 65.

[25] One plausible cause of this inadequate sensitivity of WTP to magnitude of risk reduction is difficulty in communicating small risk changes to survey respondents. Tests have shown that sensitivity of WTP to risk reduction is influenced by methods for communicating risk. Phaedra S. Corso et al. tested the use of three visual aids to communicate small risk-changes and found that, while estimated WTP was nearly proportional to the risk reduction for some visual aids, WTP did not vary with risk reduction for respondents who were provided with no visual aid. *See* Phaedra S. Corso et al., *Valuing Mortality-Risk Reduction: Using Visual Aids to Improve the Validity of Contingent Valuation*, 23 J. RISK & UNCERTAINTY 165 (2001). James K. Hammitt and Kevin Haninger found that estimated WTP to reduce the risk of nonfatal illness was proportional to the risk-change when using a visual aid similar to the one that performed best in the Corso et al. analysis. *See* James K. Hammitt & Kevin Haninger, *Willingness to Pay for Food Safety: Sensitivity to Duration and Severity of Illness*, 89 AM. J. AGRIC. ECON. 1170 (2007).

[26] *See* Graham, *supra* note 1, at 423-30.

[27] *See id.* at 408-09.

takes on a normative (i.e., prescriptive or paternalistic) character. In this case, BCA identifies policies that experts think the public should prefer, with the knowledge that the public, using their own perceptions and values, may oppose these policies.

It seems clear that individuals would wish for experts to correct for clear mistakes (such as susceptibility to framing), but this raises the question of which frame provides the more accurate reflection of individuals' preferences? If the frequently observed departure of WTP from proportionality to risk magnitude is accepted as erroneous, then analysts must determine which rate of substitution between money and risk more accurately characterizes public preferences. In the example cited above, is the median WTP of £50 for a reduction in risk of 4/100,000 (implying a VSL of £1.2 million) or the median WTP of £50 for a reduction in risk of 7/100,000 (implying a VSL of £710,000) a better estimate of public preferences? Also, when estimates of public WTP are used in BCA when a WTA value is available and conceptually more appropriate (e.g., when valuing harms), the analyst has substituted an expert evaluation for a lay evaluation (i.e., that the WTP estimate is a better estimate than the WTA estimate of VSL), and so the assertion that the BCA describes public preferences becomes tenuous.

The tension between positive and normative conceptions of BCA reflects a larger tension in representative democracies—the tension between electing representatives who attempt to mimic the policies that would be adopted by direct democracy and electing representatives who lead the citizenry in directions it does not yet know that it will prefer. In the area of lifesaving regulation, the stakes are large, the issues are profound, and there is much room for confusion. By providing an integrated framework to account for the consequences of regulation and making estimates of the magnitudes of these consequences explicit and open to review and challenge, BCA provides a valuable tool for guiding regulatory decision making. As Graham shows, this tool is not perfect, but it is susceptible to improvement.[28] Methods for quantitatively incorporating equity considerations, such as the supplemental compensation test Graham proposes,[29] should make BCA even more valuable.

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[28] *See id.* at pt. V.

[29] *See id.* at 516-24.

Preferred Citation: James K. Hammitt, Response, *Saving Lives: Benefit-Cost Analysis and Distribution,* 157 U. PA. L. REV. PENNUMBRA 189 (2009), http://www.pennumbra.com/responses/03-2009/Hammitt.pdf.