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Risk-Risk Analysis

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Abstract

Constraints on the use of benefit-cost tests have generated increased interest in risk-risk analysis as a regulatory test. The effect on individual mortality of the income losses arising from regulatory expenditures can be determined from direct empirical estimates, which this article surveys. The article proposes an alternative formulation based on information on the value of life and the marginal propensity to spend on health, which implies a loss of one statistical life for every $50 million in expenditures. Occupational injury and fatality costs caused by expenditures represent another type of risk tradeoff that could be considered within risk-risk analysis or, more generally, a benefit-cost test.

Key words: risk-risk analysis, value of life, mortality, benefit-cost analysis

1. Risk-risk analysis tests

Although economists have long advocated the use of benefit-cost tests for risk regulation, this approach has seldom been reflected in risk regulation policy making. Perhaps in part because of a reluctance to convert health outcomes into a monetary metric, U.S. regulatory agencies have largely based risk regulations on narrower criteria. These guidelines have reflected agencies' legislative mandates, which in many cases prohibit policy decisions based on benefit-cost analysis. In some cases, the legislation prohibits consideration of economic costs altogether.

The narrow range of considerations that can influence policy choice has generated increased interest in various forms of risk-risk analysis.[1] In particular, if only the implications of policies pertaining to risk aspects are pertinent, how should one structure the policy approach? Even if one is solely concerned with risk reduction, it will not always be desirable to set risk regulations at their most stringent level. Important risk tradeoffs may exist. The focus of this volume is on these risk-risk tradeoffs, with principal emphasis on the linkages between regulatory costs, individual income, and mortality.

Perhaps the most direct form of risk-risk analysis is that the policy may pose multiple risks. Consider the case of saccharin, which is the artificial sweetener that was the object of controversy in the mid-1970s. Based on a Canadian study of rats that had been fed saccharin, the FDA concluded that saccharin was a potential carcinogen with a lifetime

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cancer risk of 1/10,000. Although the FDA originally sought to ban saccharin, the public resisted this action because saccharin was the most prominent artificial sweetener. In this case, there was an explicit tradeoff between the risks posed by obesity and the risks of cancer, which the U.S. and Congress finessed by mandating hazard warnings for saccharin.

Similar kinds of risk-risk tradeoffs are generated by other policies as well. Chlorination of water is beneficial since it reduces the spread of a wide variety of diseases, but chlorinated water is also carcinogenic. Similarly, government mandates to promote greater fuel efficiency in cars will reduce the health risks associated with air pollution, but the downsizing of cars has increased automobile fatalities by 1,600–3,000 per year.[2] For this regulation to be attractive, the health gains from the increased pollution must outweigh the greater risks associated with smaller and more fuel-efficient cars.

A second kind of risk-risk tradeoff arises from the influence of offsetting behavior on the part of those affected by the policy. Those who wear seatbelts may drive faster than they otherwise would, muting some of the safety benefits for passengers. If these motorists kill a sufficiently increased number of pedestrians and motorcyclists, the overall risk may be greater.[3] Similarly, in the case of safety caps, consumers may incorrectly believe that the caps are childproof and increase children's access to products with such caps.[4] Safety caps may also not have their intended effect if their designs create such great difficulties for consumers that they leave the caps off altogether. There also may be a diminished level of precautions arising from a rational perception of the adequacy of these caps, with the net effect of each of these influences being to dampen the potential efficacy of the regulation. Similar types of concerns arise with respect to the new child safety mechanisms for cigarette lighters, which have just been mandated by government regulations. In this case the risk reduction effects of the safety mechanism appear to outweigh the increased riskiness of individual behavior.[5]

A third type of risk-risk tradeoff arises because regulatory expenditures may directly lead to injuries and death. All economic activities in the economy generate some risk. To the extent that government regulations mandate other economic efforts, such as the installation of pollution-control equipment, there will be some injuries and deaths associated with manufacturing of this equipment.

To date, analysts have not attempted to assess these risk effects because of the difficulty of isolating the level of the risk associated with activities of different industries as final products as opposed to inputs to other industries.[6] The paper in this volume by Viscusi and Zeckhauser represents the first attempt to estimate the fatality and injury costs of expenditures for different industries, where we use input-output analysis to isolate the final product risks and intermediate output risks and to determine the total direct and indirect risks of expenditures. This analysis suggests that the risk costs of expenditures may be substantial, usually on the order of 3–4% of total costs. Even if one is solely concerned with the risk effects of policies, then the occupational risks associated with regulatory activities outweigh the risk reductions of many regulatory efforts.

The principal focal point of this special issue will be on the form of risk-risk analysis that arises from the linkage between individual health status, wealth, and regulatory expenditures. As has long been observed in the risk regulation literature by Viscusi

(1978, 1983) and Wildavsky (1980, 1988), there is a direct linkage between wealth and individual risk. In particular, more affluent individuals and societies will be more likely to select lower levels of risk. This phenomenon is reflected in the increased safety of society throughout this century.

The direct link of this influence to policy analysis has been developed in the recent work by Keeney (1990), who constructed empirical estimates for the level of regulatory expenditures that would be needed to induce one statistical death. Keeney's estimates and advocacy of this policy approach in turn became the basis for a U.S. Federal Court decision[7] as well an effort by the regulatory oversight group in the U.S. Office of Management and Budget to incorporate this relationship in a policy test that regulatory agencies would need to meet.[8]

This special issue features some original research on the issue by many of the principal players in the spirited debate generated by this new risk-risk concept, as well as commentary on the general approach.[9] The article in this volume by Keeney provides an overview of the risk/risk analysis concept for the income-risk relationship and includes a detailed assessment of its potential use for policy. The article by Lutter and Morrall, the two economists at the U.S. Office of Management and Budget most responsible for raising this policy issue throughout the U.S. government, provides a detailed advocacy of risk/risk approach as a policy test. These empirical estimates are based on direct evidence regarding the association of financial resources and mortality.

The empirical studies of the income-health relationship are controversial, primarily because the simultaneous relationship between wealth and health has not been satisfactorily resolved. In the Portney and Stavins article in this volume, the authors provide a critical view of the concept as a basis for policy decisions. The article by Smith et al. in this issue provides a detailed critique of existing studies, such as that by Lutter and Morrall, which rely on direct estimation of the risk-wealth relationship. Smith et al. question the robustness of the income-mortality estimates based on international data and find that differences in economic freedom may account for much of the income-mortality link. These findings raise questions for future research as to what the economic freedom measure and income-mortality correlations are capturing. They may reflect differences in lifetime wealth as well as in individuals' ability to alter their safety precautions. The article by Chapman and Hariharan improves upon existing studies of the income mortality relationship by controlling for initial health status, thus eliminating much of the problem arising from reverse causality.

As I indicate in section 3 below, there is an alternative methodology for assessing the effect of regulatory costs on health status by linking these estimates to empirical estimates of the value of life. This approach avoids the controversies that have been associated with the direct estimates of the income-health linkage.

2. The mortality-income relationship

For the risk-risk test in which regulatory costs make citizens poorer, the main matter of concern is the extent to which regulatory expenditures will affect individual mortality.

With one exception, all studies of this relationship have relied upon direct estimates of the mortality-income linkage.

This approach has the advantage of focusing explicitly on the matter of concern, but it suffers from several weaknesses with respect to difficulties in accurately assessing the linkage. Table 1 summarizes five previous studies and two new studies from this volume that examine the relationship between income and mortality. In each case, the authors undertook a statistical analysis of the relationship between income levels and mortality, where the number of other variables affecting mortality depended on the study. Of the previously published articles, only the Keeney (1990) paper calculates an income loss per statistical death. This estimate was updated to current price levels, and the results of the other studies were converted to a cost per statistical death amount.

The estimates summarized in Table 1 indicate that the income loss associated with one statistical death ranges from $1.9 million–$33.2 million dollars (November 1992 dollars), depending on the particular study. The article by Chapman and Hariharan in this volume yields estimates in the middle of the range, i.e., an expenditure of $13.3 million generates one statistical death.This amount is above the Lutter and Morrall estimate of $9.3 million (all in November 1992 dollars). As is indicated by the middle column of information, these studies differ widely in the time period analyzed, the sample being addressed, and the other variables taken into account.

Table 1. Summary of income-mortality studies

Study	Nature of relationship	Income loss per statistical death $ millions (Nov. 1992 dollars)
Hadley (1982)	1% increase in total family income for white males age 45-64 leads to .07% decline in mortality.	33.2
U.S. Joint Economic Committee (1984)	3% drop in real per capita income in 1973 recession generated 2.3% increase in mortality.	3.0
Anderson and Burkhauser (1985)	Longitudinal survey, Social Security Administration Retirement History Survey, 1969–1979. $1 difference in hourly wage levels in 1969 generates 4.2% difference in mortality rates over next 10 years.	1.9
Duleep (1986)	Social Security mortality data 1973–1978 for men aged 36–65 imply a higher mortality rate of .023 for income group $3,000–$6,000 compared to income group $6,000–$9,000.	2.7
Keeney (1990), based on Kitagawa and Hauser (1983)	Mortality rate-income level data, fit expositional curve relating mortality rates to income, 1959 data on mortality of whites, age 25-64, death certificate information.	12.5
Lutter and Morrall (1993)	International data on mortality-income relationship from the World Bank, 1965 and 1986.	9.3
Chapman and Hariharan (1993)	Social Security Administration Retirement History Survey, 1969–1979, controlling for initial health status; tradeoff of $12.2 million per life in 1969 dollars.	13.3

First, the data available are not the result of pure experiments in which income is varied, leading to observable effects on mortality. Instead, income differences in different groups of the population or different countries are compared. Since income levels are correlated with other mortality-affecting characteristics such as education, there is the possibility that personal characteristics correlated with income will influence the results.

A second difficulty is that the causality is two-directional. Although higher income levels enhance individual health, improved health status also increases individuals' earnings capabilities. This concern is most explicitly addressed in the Chapman and Hariharan article.

Third, there is often an inappropriate match between the unit of observation for the income level and the unit of observation for mortality. In some cases, the income level of the individual, typically the household head, is linked to the individual's mortality, whereas all family members' mortality may be affected by these earnings. In other cases, total family income is linked to the mortality of the household head. To date, there has been no study that has addressed the public-good aspect of family income to assess the effect of total family income on the mortality of all family members.

3. The value-of-life linkage

Taken at face value, many of the results summarized in Table 1 suggest that the regulatory expenditure that will generate the loss of one statistical life may be quite low, perhaps under \$5 million dollars and almost certainly under \$13 million. These figures are true not only of regulatory expenditures, but also of any individual expenditures. Because of the low level of expenditures that will lead to a death, there appears to be an inconsistency with individuals' willingness to pay a comparable amount to prevent their death.

The literature survey presented in Viscusi (1992) suggests that the evidence on the marginal value of life from the labor market indicates that this value is in the range of \$3 million dollars–\$7 million dollars. If we take the mid-point of this range, \$5 million dollars, as the point estimate for the subsequent discussion, we are in the curious position of having the expenditure that will generate the loss of a statistical life possibly being of roughly the same magnitude or perhaps even below the amount people are willing to spend to reduce risk.

These numbers are in fact closely related. As I have shown in Viscusi (1992b, in press), the expenditure that will generate the loss of one statistical life is quite directly linked to the marginal value of life from the standpoint of prevention by the following equality:

$$\text{Marginal expenditure per statistical life lost} = \frac{\text{Marginal value of life}}{\text{Marginal propensity to spend on health}} \tag{1}$$

If the marginal propensity to spend out of income on health-related goods that affect mortality (denoted by $\delta h/\delta A$ below) is 1.0, then the marginal expenditure per statistical life lost will equal the marginal value of life. Since all of individuals' additional income is not devoted to mortality-reducing health expenditures, in general the marginal expenditure per statistical life will exceed the marginal value of life. Thus, the critical question is the extent to which individuals will spend on health out of their income. Information pertaining to the denominator of the right side of equation (1) can then be used in conjunction with existing estimates of the value of life to calculate the marginal expenditure per statistical life lost.

The simplification that will be made below is that I will treat all health care expenditures as being those that are most directly related to mortality reduction. In terms of the average propensity to consume out of income, health care expenditures represent 12% of personal income and 14% of disposable personal income. If one were to also add the contributions of food to individual budgets, the average propensity to spend on medical care and food would be 25% of personal income and 28% of disposable personal income. These figures might best be regarded as an upper bound on the possible denominator for the right side of equation (1), so that the marginal expenditure per statistical life lost is at least 3–4 times as large as the marginal value of life.

To obtain a more precise estimate of the marginal propensity to spend on health out of income, two approaches will be used. First, I will analyze international data, pooling time series and cross-sectional data on a variety of countries to obtain estimates of the marginal propensity to consume health care out of income. As is indicated in Phelps (1992), since the initial study by Newhouse (1977) there has been little change in the set of variables examined. Perhaps the major advance has been the availability of more detailed data across countries, but personal income continues to be the dominant explanatory variable in these studies.

Table 2 presents a summary of the pooled time series and cross-section results for 24 Organization for Economic Cooperation and Development (OECD) countries for the years 1960–1989. Each of the 6 equations reported in Table 2 utilizes the natural logarithm of the per capita health expenditures as the dependent variable, where the equations are estimated using weighted least squares. The weights used were based on the country populations by year. Equations 1–3 convert the monetary units into U.S. dollars based on the prevailing exchange rates in each year, whereas equations 4–6 use purchasing power parity rates that establish each country's currency in terms of an OECD market basket of goods. The purchasing power parity approach provides a more stable index of the year-to-year fluctuations in health care expenditures, but will not prove to be of substantial consequence in influencing the estimated marginal propensity to consume on health care.

Each of the regression equations includes as an explanatory variable the natural logarithm of the gross domestic product per capita. This variable alone has extremely high explanatory power, as is evident from the very high $\bar{R}^2$ values for equations 1 and 4.

Equations 2 and 5 add the natural logarithm of the unemployment rate to the equation. This variable is not statistically significant in equation 2 and falls just shy of statistical significance (one-tailed test) in equation 5. Equations 3 and 6 include a much more extensive set of variables to take into account cyclical factors and inter-country differences. In particular, these fixed-effect regressions include 29 dummy variables for each of the years as well as 23 dummy variables for the different countries.

Table 2. Log per capita health expenditure weighted least-squares regressions with OECD data, 1960–1989

Independent variables	1	2	3	4	5	6
Intercept	−4.432 (0.043)	−4.353 (0.049)	−3.552 (0.106)	−4.586 (0.550)	−4.522 (0.065)	−3.739 (0.292)
Ln (gross domestic product per capita)	1.207 (0.005)	1.196 (0.007)	1.091 (0.017)	1.224 (0.007)	1.221 (0.009)	1.114 (0.044)
Ln (unemployment rate)	—	0.008 (0.011)	−0.006 (0.008)	—	−0.022 (0.013)	0.002 (0.009)
Other variables included, comments	—	—	29 year dummy variables, 23 country dummy variables	Purchasing power parity	Purchasing power parity	Purchasing power parity, 29 year dummy variables, 23 country dummy variables
$\bar{R}^2$	.987	.986	.998	.980	.978	.997
Sample size	675	589	589	671	585	585
$\partial h/\partial A$	.089	.089	.081	.089	.089	.081

Table 3. Log per capita expenditures OLS regressions with U.S. data, 1960–1989

Independent variables	1	2	3
Intercept	−4.320 (0.053)	−4.324 (0.059)	−2.231 (0.207)
Ln (gross domestic product per capita)	1.215 (0.006)	1.214 (0.009)	0.858 (0.035)
Ln (unemployment rate)	—	0.007 (0.035)	0.112 (0.019)
Time	—	—	0.045 (0.004)
$\bar{R}^2$	.9992	.9991	.9998
Sample size	29	29	29
$\partial h/\partial A$	.123	.121	.085

The primary result in Table 2 that is of interest concerns the marginal propensity to spend on health care out of changes in gross domestic product per capita (i.e., $\partial h/\partial A$). As the final row in Table 1 indicates, the estimates for $\partial h/\partial A$ cluster around .09.

One obtains similar results if one focuses only on U.S. time series data, as reported in Table 3. Per capita gross domestic product continues to be the chief explanatory variable, and, as these results indicate, has substantial explanatory power. For each of the regression equations reported in Table 3, there is a positive significant effect of gross domestic product per capita on health care expenditures. Moreover, this variable plays a dominant role, as shown by the extremely high explanatory power evidenced in equation 1. The addition of the unemployment rate to equation 2 does not lead to a statistically significant coefficient, but the dummy variable counter for time in equation 3 does indicate a positive upward trend in health care expenditures. Interpretation of this influence of temporal trends is somewhat unclear due to the strong correlation between the time trend variable and changes in gross domestic product per capita.[10] Even after including this variable, the marginal propensity to consume health care out of one's income remains in the vicinity of .10. In particular, the estimates in the bottom row of Table 3 for $\partial h/\partial A$ range from .085-.123.

The implication of both the United States data and the international data for the marginal propensity to spend on medical care out of income is that this value is in the range of .1. If this is the figure used as the denominator in equation (1) in conjunction with a value-of-life range of \$3 million–\$7 million dollars, these estimates imply that the marginal expenditure that will lead to the loss of one statistical life ranges from \$30 million–\$70 million dollars, with a mid-point value of \$50 million dollars. This figure exceeds the estimates based on direct assessment of the mortality-income linkage reported in Table 1.

4. The Superfund example

The application of these and other risk effects of regulatory expenditures can be illustrated within the context of the Superfund effort. This program of the U.S. Environmental Protection Agency is targeted at cleaning up existing hazardous wastes.The cost associated with this effort are quite substantial, and a number of observers have questioned whether the benefits are commensurate with the costs being imposed. Here I will not make any broad judgments regarding the desirability of the program, but will indicate how the analysis of risk-risk effects could be applied in this particular instance.

Table 4 provides two different cost levels associated with Superfund. The low-end cost figure of \$36 billion dollars is based on an average cost of \$30 million dollars per site, where the number of sites being considered is restricted to those sites currently on the National Priorities List. This list is not fully comprehensive, as the U.S. Environmental Protection Agency has identified thousands of sites not currently on the National Priorities List. In addition, many observers believe that the cleanup costs could be higher, with these estimates frequently being in the range of \$50 million dollars per site. Since very few sites have been cleaned up completely—63 of 34,652 sites have been cleaned up as of June 30, 1991, with this number rising to 149 by September 1992—considerable uncertainty remains with respect to the average costs of cleanup that will ultimately be incurred.

The first component of the risk effects pertains to the direct value of deaths and injuries generated by the expenditures needed to clean up the site. For the most part, these expenditures are for the construction industry as opposed to, for example, manufacturing. If the estimate presented in the Viscusi and Zeckhauser article of a value of injury and fatality costs of 4.1% of total construction expenditures is used, then the direct health costs generated by regulatory expenditures will be \$1.5 billion for the low-end estimate and \$12.3 million for the high-end Superfund cost estimate.

Table 4. Health effects of Superfund cleanup costs

	Cost Level (in dollars)	
	$36 billion (No additional sites, $30 million per site)	$300 billion (Projected additional sites, $50 million per site)
Direct risk effects:		
Value of lives and injuries due to direct production risk	$1.5 billion	$12.3 billion
Mortality-income effects of regulatory costs:		
Lives lost	720	6,000
Value of lives lost (at $5 million per life)	$3.6 billion	$30 billion
Policy tests:		
Total health-risk costs	$5.1 billion	$42.3 billion
Health-risk costs as a percent of total costs	14	14
Critical cost-per-life threshold for beneficial health effects	$35.7 million	$35.7 million

The next row of Table 4 focuses on the health loss due to the effect of regulatory expenditures on individual income. Applying my estimates that one statistical life will be lost for every $50 million in expenditures, then there will be a loss of 720 statistical lives for the low-end estimate of $36 billion and 6,000 statistical lives lost for the high-end estimate.[11] If one applies a value-of-life estimate of $5 million per life to this figure, one obtains the total value-of-life loss estimate due to the mortality-income linkage given in the third row of Table 4.

There are three ways in which these effects can be converted into a form that would be of use from the standpoint of policy. The first is the total health-risk costs of regulatory expenditures, which is $5.1 billion for the low-end Superfund cost estimate and $42.3 billion for the high-end estimate. If the direct health-risk benefits of Superfund have a lower value than these magnitudes, then on balance the policy will impose more health-risk costs than benefits even from the standpoint of health risk alone, and should not be pursued. Viewed somewhat differently, the health-risk effects are 14% of the total costs. Thus, unless the direct health-risk benefits are at least 14% of costs, then from the standpoint of risk-risk analysis, these policies should be rejected.

The final row of Table 4 converts these estimates into a critical cost-per-life-saved threshold. If the Superfund policy imposes a cost-per-life-saved above this amount, then the net effect of the policy on health will be adverse. Similarly, if the cost-per-life-saved is less than this amount, the effect of the policy will be favorable. Thus, rather than focusing on a critical value of life of $5 million per life saved which is the potential benefit-cost reference point, the risk-risk cutoff is $35.7 million dollars per statistical life. Policies costing more than this amount per life saved will not be beneficial from a health standpoint.

This figure will differ for other policy situations. Although the mortality-income figures will not vary with the policy context, if the industrial incidence of the regulatory expenditures does not involve construction expenditures, one would need to modify the direct-risk effect estimates in the first row of Table 4 to take this into account.

5. Issues for policy evaluation

Although there are many contexts in which risk-risk analysis can be productive, one would seldom make the argument that it is superior to benefit-cost analysis from an economic standpoint. However, risk-risk methodology does successfully focus on the risk effects of the policy, which is often particularly useful in contexts in which there is a reluctance to make tradeoffs between costs and health. As a mechanism for eliminating policy options that are clearly not to society's benefit, risk-risk analysis may offer greater promise than many other approaches, such as cost-effectiveness analysis, which seldom comes into play in actual policy contexts.[12]

Even if one accepts benefit-cost analysis as the ideal, one might well inquire as to whether the types of concerns embodied in risk-risk analysis also should influence benefit-cost tests. The risk effects of regulation that arise through the direct effect of regulatory expenditures on injuries will be largely taken into account if costs are properly recognized. If the risks associated with industrial activities are internalized by the industries, then the prices paid for the commodities generated by these industries will reflect the social value of these risks to the workers. However, these values will not encompass all the social costs associated with industrial risks, since environmental externalities and inadequately perceived risks of the job will not generate compensation. A complete analysis would also account for these influences.

The effect of regulatory costs on mortality that results from the income-mortality relationship also represents an effect of regulations that should be incorporated within the context of a benefit-cost approach. As is shown in Viscusi (1992b, in press), risk regulations also reduce risks that individuals face, thus enabling them to decrease the private expenditures made to enhance personal safety. Taking these income-mortality risk effects into account as well as the influence of government regulations as a substitute for private self-protection does lead to an amendment of the appropriate benefit-cost test, but these changes are not dramatic (see Viscusi, 1992b, in press). The income-mortality risk relationship is most consequential within the context of risk-risk analysis.

One seeming limitation of risk-risk analyses based on income-mortality risk linkage is that only mortality risks are being considered. Other health effects may also result from regulatory expenditures and their effect on decreasing individual income. Broadening the analysis in this manner is not an inherent limitation of the methodology, which presumably as it becomes more refined, can take account of other health effects as well. As was shown in the case of direct risk effects of regulatory expenditures, generalizing the analysis to include nonfatal injuries as well as fatalities may be quite straightforward. If nonfatal risk effects are omitted, the risk-risk test that will be applied will not be sufficiently stringent in eliminating policies that in fact have an adverse risk effect on society.

An additional concern related to the tradeoff metric pertains to the nature of the risks being compared. Although health risks are frequently a prominent component of the benefits of regulatory programs, there may be other risk effects that are consequential as well, such as the preservation of an endangered species. A risk-risk analysis is not disadvantaged relative to benefit-cost analysis in making such comparisons, because one can establish a monetary metric for the different effects. This was in fact done in the Superfund analysis above, in which all of the health and environmental effects were translated into monetary terms. In other policy contexts, I have also used a metric based on lotteries on life and death. Although some observers may object that a comparison of fatality costs to preservation of animal species is unfair and will be to the disadvantage of these endangered species, these are in fact the tradeoffs that society is making through these policies. It is more sensible to confront these tradeoffs directly rather than to assume that they do not exist by ignoring them altogether. The long-run effect of adopting a risk-risk approach may be to force analysts to evaluate more of the outcomes and compare them using a comparable metric.

Much of the criticism of the initial policy suggestions regarding the adoption of the risk-risk approach arose from the uncertainties pertaining to empirical estimates of the mortality risk-income relationship. As was noted above, these estimates are quite diverse. However, one would expect these estimates to be refined, particularly once they became of central interest to policy makers as opposed to being a minor topic in the health economics literature. In addition, as was noted above, one need not rely on direct empirical estimates of the income-mortality risk relationship; such estimates are fraught with inherent difficulties. Rather, one can utilize information pertaining to the appropriate value of life from the standpoint of prevention, in conjunction with the marginal propensity to spend out of income on health, to obtain estimates of the regulatory expenditure that will generate the loss of one statistical life.

These uncertainties in valuation are not unique to risk-risk analysis. Other components of the benefits and costs that comprise the typical regulatory analyses are often not known with precision. Estimates by the U.S. Environmental and Protection Agency with respect to the externalities associated with the use of coal range by a factor of 50. This range, moreover, only reflects the spread over EPA's assessment of the reasonable range of uncertainty, and does not reflect the full extent of our ignorance. Dose-response relationships that form the basis of most risk assessments are typically not well understood, but few critics have suggested risk assessments be disregarded altogether until all scientific uncertainties are resolved. By their very nature, policies to reduce risk involve inherent uncertainties, and the task for policymakers is to adopt those policies that will yield the greatest expected net benefits to society.

There are other kinds of refinements that could be made in these approaches as well. There may be heterogeneity in the effects pertinent to risk-risk analysis for different areas and across different population groups. Differences in the direct effect of regulatory expenditures on safety across industries were assessed in the Viscusi and Zeckhauser article; presumably, one might also explore differences across income groups in the income-mortality risk relationship. One might expect, for example, that individuals in low-income groups would have a greater mortality response to a decrease in income than would those in higher income groups.[13]

A final objection that might be raised against these various risk-risk approaches is political. Some critics have suggested that the reason such approaches have been embraced is that policymakers are simply seeking a political mechanism to limit environmental regulations. Imposing limits is not necessary undesirable, however. The task of regulatory oversight is to ensure that the risk regulations being issued are in society's best interest. If in fact these regulations do more harm than good, then they should not be pursued. The risk-risk test simply poses a basic risk policy question: Do these regulations kill more people than they save? If so, then irrespective of their cost they should not be pursued. Concerns such as these are quite legitimate, wholly apart from their political motivation. Our task as risk analysts is to foster risk regulations that decrease the risks we face rather than increase them.

Notes

1. For an excellent overview of various forms of risk-risk analysis, see Lave (1981).
2. See Viscusi (1991) for discussion of this tradeoff.
3. Peltzman (1975) explores this relationship using U.S. auto fatality data.
4. See Viscusi (1992a) for a review of my analysis of this phenomenon.
5. This conclusion is based on my unpublished joint research in Viscusi and Cavallo (1993).
6. The issues involved with respect to disentangling these effects, as well as the possible solution to them, have been identified by Lave (1981), although he does not pursue empirical estimation of these issues.
7. For the discussion of this decision and the issues surrounding it, see Judge Steven Williams (1993).
8. See the letter from James B. MacRae, Jr., Acting Administrator, Office of Information and Regulatory Affairs, U.S. Office of Management and Budget, to Nancy Risque-Rohrbach, Assistant Secretary for Policy, U.S. Department of Labor, March 10, 1992, and the statement of James B. MacRae, Jr. before the Senate Committee on Governmental Affairs, March 19, 1992.
9. Many of the academic researchers have been involved in policy aspects as well. My recent work on this topic began with a 1992 report prepared for the U.S. Office of Management and Budget, and my current work is funded by the U.S. Environmental Protection Agency. Many of the participants in this volume serve on the EPA Science Advisory Board that considered this policy issue for EPA (Paul Portney, V. Kerry Smith, Robert Stavins, and myself).
10. Reliance on time-series data does have important limitations. Chief among these is that it captures not only the role of income but also technological change over time. Ideally, one would like to fix the technologies available and undertake an experiment in which we determine how changes in income influenced the amount of health care one would choose to purchase from a given set of technologies. Inclusion of the time trend variable in Table 3 should, however, reflect these influences, at least in part, as should the year dummy variables in Table 2. Moreover, rising income levels may affect the choice of technology over time.
11. Consideration of nonfatal injuries would increase this health cost even further.
12. One reason that cost-effectiveness issues are not salient parts of the policy debate may be that agencies have already internalized many of these principles in the initial policy design.
13. If that is the case, there would be an added rationale for pursuing the risk-risk approach since it would recognize the kinds of effects that are likely to be most salient for those in the more disadvantaged income groups. Individual valuations of those deaths will, however, be lower, since there is a positive income elasticity of the value of health.

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