

September 1999

Health Transfers: An Application of Health-Health Analysis to Assess Food Safety Regulations

Fred Kuchler

Jackqueline L. Teague

Richard A. Williams

Don W. Anderson

Follow this and additional works at: <https://scholars.unh.edu/risk>



Part of the [Aquaculture and Fisheries Commons](#), [Economics Commons](#), and the [Food Security Commons](#)

Repository Citation

Fred Kuchler, Jackqueline L. Teague, Richard A. Williams & Don W. Anderson, *Health Transfers: An Application of Health-Health Analysis to Assess Food Safety Regulations*, 10 RISK 315 (1999).

This Article is brought to you for free and open access by the University of New Hampshire – School of Law at University of New Hampshire Scholars' Repository. It has been accepted for inclusion in RISK: Health, Safety & Environment (1990-2002) by an authorized editor of University of New Hampshire Scholars' Repository. For more information, please contact ellen.phillips@law.unh.edu.

Health Transfers: An Application of Health-Health Analysis to Assess Food Safety Regulations*

Fred Kuchler, Jacqueline L. Teague, Richard A. Williams & Don W. Anderson **

Introduction

Policies designed to lower particular public health risks may unintentionally raise other health risks. Health policy analysts have long recognized this premise. We examine one of the mechanisms through which health risks may rise. A potential Gulf oyster harvesting ban to control fatalities from exposure to *Vibrio vulnificus* illustrates the quantitative comparison of reductions in target risks to adverse health outcomes. We estimate both the number of unintended adverse health outcomes and the distribution of those outcomes throughout the population. We also identify subpopulations by gender and ethnicity and provide a count of induced deaths for each. The illustration shows it is possible to measure both net health benefits and the extent to which public sector health and safety programs transfer risks, and hence health, from one group to another.

Lester Lave argues that analysts could gauge the net health benefits of public intervention using Risk-Risk Analysis, revealing that substitute risks often replace risks public health policies reduce.¹ For example,

* Teague & Anderson acknowledge support of the Economics Branch of the Center for Food Safety and Applied Nutrition at the U.S. Food and Drug Administration (FDA). The authors also gratefully acknowledge the comments on earlier drafts provided by Dr. Randall W. Lutter of the Office of Management and Budget, Dr. Jean Buzby and Dr. Elise Golan of the U.S. Department of Agriculture (USDA), Dr. Josephine A. Mauskopf and Dr. Gary A. Zarkin of Research Triangle Institute (RTI), and three anonymous reviewers. This paper was prepared by the authors alone, and any views or opinions expressed herein do not necessarily reflect those of the FDA, the USDA, or RTI.

** Dr. Kuchler is an economist with the USDA. He holds an A.B. (Economics) from the University of California, Davis and an M.A. and Ph.D. (Economics) from Virginia Polytechnic Institute and State University. E-mail: fkuchler@econ.ag.gov.

Ms. Teague is an economist with RTI. She holds a B.A. (English) from Wake Forest University and an M.A. (Economics) from North Carolina State University, Greensboro.

treating drinking water with chlorine reduces the incidence of some diseases, but exposure to chlorine raises the risk of cancer.

There is another mechanism through which adverse unintended health outcomes result from public sector efforts to manage health and safety risks. Public sector actions may exert a negative influence on health due to limited resources. As the public sector expands its attempt to manage risks, it may reduce the ability of the private sector to do so because new health and safety programs, like any new public sector programs, will be accompanied by new costs. New regulatory compliance costs or taxes required to finance such programs reduce disposable income of those who incur the costs or bear the taxes. A consequence of reduced income is less ability to privately purchase goods and services, including those that reduce risks and promote health. As individuals take additional risks, additional adverse health outcomes may result.

Randall Lutter and John Morrall describe the small set of regulatory and judicial decisions regarding workplace safety that this logic influences.² They argue that analysts can compare a count of fatalities *averted* by public sector programs with the fatalities *induced* by regulatory costs. They title the comparison "Health-Health Analysis." When analysts make the comparisons Lutter and Morrall suggest, they are constructing information that a judge can use to determine whether a program is a desirable or undesirable use of public resources. Lutter and Morrall argue that, at a minimum, a program ought to yield more lives saved than lives lost.

Economists take for granted that income influences individual risk choices and thereby influences health. In tallying regulatory costs and benefits, analysts usually know who will bear the costs, and analysts can estimate the cost bearers' income. However, to estimate the number of

Dr. Williams is Director of the Division of Market Studies, Center for Food Safety and Applied Nutrition, FDA. He holds a B.A. (Economics) from Old Dominion University and a Ph.D. (Economics) from Virginia Polytechnic Institute and State University.

Mr. Anderson is Senior Economist with RTI. He holds an M.A. (Economics) from North Carolina State University.

¹ See Lester Lave, *The Strategy of Social Regulation: Decision Frameworks for Policy* (1981).

² See Randall Lutter & John F. Morrall III, *Health-Health Analysis: A New Way to Evaluate Health and Safety Regulation*, 8 *J. Risk & Uncertainty* 43 (1994).

fatalities a proposed regulation might induce, analysts need to know how income loss is likely to affect the health of those who will bear regulatory costs. The initial Health-Health Analysis (HHA) applications, as well as the more recent applications to air quality standards,³ relied on estimates of mortality rates associated with average income levels. These applications are admittedly imprecise; regulatory costs may fall on people whose income is not average. In this article, we illustrate the application of HHA using new estimates of the linkage between income and health for specific subpopulations.

We estimate the number of lives lost by identifying which subpopulations are likely to experience a fall in income and how the health of those groups is likely to react. Ralph Keeney estimates the relationship between income and mortality by demographic category.⁴ We use his results to transform increased regulatory costs into increases in premature deaths for different subpopulations. The sum of the subpopulation counts is our estimate of regulation-induced deaths. Unlike previous analyses, our estimate shows that analysts can account for the current distribution of income, the magnitude of income losses, and demographic variables, factors that vary the health loss resulting from income loss.

There is a second benefit to constructing lives lost by subpopulation. Listing the losses shows whose health might be compromised by a government program. That is, the lists show clearly how health is transferred from one subpopulation to another.

Using results from Anderson et al.,⁵ we estimate mortality effects of a potential oyster harvesting ban to protect consumers from the pathogen *Vibrio vulnificus*. Their study estimates the income losses derived from several approaches to control fatalities resulting from the consumption of oysters contaminated by *Vibrio vulnificus*. The bacteria *Vibrio vulnificus* occurs naturally in estuarine waters and is a normal flora in molluscan shellfish, mainly oysters and clams. Since

³ See Wendy L. Gramm & Susan E. Dudley, *The Human Costs of EPA Standards*, Wall St. J., June 9, 1997, at A18.

⁴ See Ralph L. Keeney, *Estimating Fatalities Induced by the Economic Costs of Regulations*, 14 J. Risk & Uncertainty 5 (1997).

⁵ See Donald W. Anderson et al., *Costs of Restrictions on Gulf Oyster Harvesting for Control of Vibrio vulnificus-Caused Disease* (RTI 1996).

1979, *Vibrio vulnificus* has been known to cause food-related illnesses resulting in acute gastroenteritis. Fulminating septicemia and death occurs among those who have preexisting liver disease.⁶ Essentially all deaths are attributed to half-shell consumption of “live” oysters harvested from the Gulf of Mexico and tributary waters between April 1 and October 31 each year. Our calculations show net impacts on averted premature deaths if authorities banned Gulf oyster harvesting from April 1 through October 31.

If public health concerns prompts authorities to prohibit the harvest of Gulf oysters from April 1 through October 31 each year, the Gulf region would suffer substantial reductions in economic activity. Not only would harvesters’ incomes diminish, but incomes of individuals employed at processing facilities, transportation companies, and elsewhere in the region’s economy would also diminish. Although a traditional public health approach might motivate a harvesting prohibition to eliminate premature deaths attributed to oyster-related illnesses, this approach alone does not consider the fatalities that such a control measure might cause through income losses. Here, we compare the targeted reduction in fatalities attributed to half-shell consumption to the induced fatalities resulting from income losses.

Regulation-Induced Fatalities

Using HHA, analysts recognize that individuals are substantially responsible for managing their risks. Individuals make risk decisions when they choose where to live and work, what kind of transportation to use or buy, and what foods to eat. In effect, each choice a person makes requires choosing their own acceptable level of risk. In each decision, the risk level choice depends, to some degree, on income. When incomes rise, risk decisions change and individuals generally purchase greater assurance of health and safety; when incomes fall, individuals cannot afford greater quantities of risk reduction. Because regulatory policies influence disposable income, policies influence the extent to which individuals can manage the risks they face.

⁶ See Interstate Shellfish Sanitation Conference (ISSC), *Draft Interstate Shellfish Sanitation Conference Summary of Actions: Thirteenth Annual Meeting*, Columbia, SC, August 1995.

In the private sector, regulatory costs affect businesses in the same way as production costs. In the long run, increases require increased prices. Market adjustments include reduced employment. Rising prices and falling incomes mean individuals less able to avoid risks.

In national or global markets, even small price increases may have measurable risk consequences. Taking only a few dollars of purchasing power does not significantly affect a person's survival risk. Yet, if everyone accepts, e.g., an additional fatality risk of one in a million, across 260 million people we could anticipate 260 induced deaths.⁷

Premature deaths from income losses follow. Education and income strongly indicate health status for both existing health stock and health production through consumption.⁸ Following income or job loss, psychological distress is one pathway for reduction in health.⁹ The health effects from unemployment or joblessness may include reduced activity and stimulation, and feelings of reduced self-worth. In addition, unemployed workers often lose their health insurance.¹⁰ Many displaced workers remain uninsured, even after re-employment.¹¹ Without health insurance, individuals may delay medical treatment.

⁷ See Kenneth S. Chapman & Govind Hariharan, *Do Poor People Have a Stronger Relationship Between Income and Mortality than the Rich? Implications of Panel Data for Health-Health Analysis*, 12 J. Risk & Uncertainty 51 (1996).

⁸ See James R. Blaylock & W. Noel Blisard, *Food Security and Health Status in the United States*, 27 App. Econ. 961 (1995) and Jonathan S. Feinstein, *The Relationship Between Socioeconomic Status and Health: A Review of Literature*, 71 Milbank Q. 279 (1993).

⁹ See, e.g., W. Fred & Gerrit Antonides, *Costs and Benefits of Unemployment and Employment*, 12 J. Econ. Psych. 667 (1991); Ralph Catalano, *The Health Effects of Economic Insecurity*, 81 Am. J. Pub. Health 1148 (1991); Robert L. Jin, Chandrakant P. Shah & Tomislav J. Svoboda, *The Impact of Unemployment on Health: A Review of the Evidence*, 153 Canadian Med. Ass'n J. 529 (1995); Anders Bjorkland, *Unemployment and Mental Health: Some Evidence from Panel Data*, 20 J. Hum. Resources 469 (1985); Rudy Fenwick & Mark Tausig, *The Macroeconomic Context of Job Stress*, 35 J. Health & Soc. Behav. 266 (1994); Bijou Yang, *The Economy and Suicide: A Time-Series Study of the USA*, 51 Am. J. Econ. & Soc. 87 (1992); Martti E. Heikkinen et al., *Age-Related Variation in Recent Life Events Preceding Suicide*, 183 J. Nervous & Mental Disease 325 (1995).

¹⁰ See Francis W. Horvath, *The Pulse of Economic Change: Displaced Workers of 1981-85*, 110 Monthly Lab. Rev. 3 (1987); Michael Podgursky & Paul Swaim, *Health Insurance Loss: The Case of the Displaced Worker*, 110 Monthly Lab. Rev. 30 (1987); Jonathan Gruber & Brigitte C. Madrian, *Employment Separation and Health Insurance Coverage*, 66 J. Pub. Econ. 349 (1997).

¹¹ See Jennifer Gardner, *Recession Swells Count of Displaced Workers*, 116 Monthly Lab. Rev. 14 (1993).

Control measures that concentrate most of the costs on a small group can create a large change in disposable income. For example, an oyster harvesting ban does not slightly reduce incomes of many people, but it significantly reduces the incomes of a few. The substantial reduction in income that follows job loss obviously affects many pathways of health production through reduced private consumption — housing, nutrition, safety, and medical care.

The number of induced deaths is likely to depend not just on the size of income loss, but also on who bears it. In particular, losses by the poor are more apt to lead to induced mortality than the same losses by the wealthy. As an illustration, suppose that individuals try to reduce risks they face as much as their income allows. The first hazards mitigated are those posing large risks that are inexpensive to address. Last on the list of hazards to be addressed would be those posing relatively small risks that are expensive. Thus, additional income given to a poor person might be used to mitigate a large risk while a wealthy person would have already eliminated that risk. Likewise, a cost imposed on the wealthy might imply a small increase in risk. The same cost imposed on the poor might imply a more substantial risk increase.

Another reason to suspect that health effects will depend on who incurs regulatory costs is that profound differences in risk attitudes exist. Risk perception studies have shown that women are typically much more likely than men to believe environmental and food contaminants are safety hazards.¹² That risk attitudes vary implies differences in willingness to prevent exposure to hazards. That is, the risk-minimizing adjustments individuals make to income losses ought not to be expected to be uniform.

Our example is not an unusual public health problem. At the outset, we know whose risks might be prevented and whose might be induced. Oyster-related deaths are concentrated among adults suffering from cirrhosis or immuno-compromising diseases, while the income losses resulting from a harvesting ban are concentrated in oystering communities. The following calculations demonstrate the possibility of transcending qualitative statements and quantitatively estimating the trade-off between the fatalities induced and prevented.

¹² See James Flynn, Paul Slovic & C.K. Mertz, *Gender, Race, and Perception of Environmental Health Risks*, 14 *Risk Anal.* 1101 (1994).

Data

HHA requires three types of information: (1) the estimate of targeted premature deaths averted by the control measure; (2) the functional relation between mortality and income; and (3) the amount of income losses associated with the public health policy. We use the latter two to estimate the induced deaths. We discuss the three types of information below.

Estimated Premature Deaths Averted by the Control Measure

In this application of HHA, the control measure under consideration is a harvesting prohibition to avoid (on average) 17 premature deaths annually attributed to illnesses raw oyster consumption causes.¹³ The Centers for Disease Control and Prevention (CDC) based this estimate on regional surveillance data from the Gulf Coast States from 1988 through 1996. The estimate also accounts for illness underreporting. The number of deaths increased over time, but whether this results from more complete reporting or an increase in incidence is unknown. Known deaths were unusually large in 1996, totaling 23. The causes of reported *Vibrio vulnificus* illnesses from 1988 through 1995, not including 1996 data, were as follows: 47% were associated with eating contaminated seafood (96% were raw oysters); 42% were associated with wound infections; and 11% were unknown.¹⁴ The CDC knew the outcomes of 242 of the 302 reported infections. Of these, 36% resulted in death. We assume that 17 premature deaths annually could be averted by an oyster harvesting ban between April 1 and October 31.

Estimated Income-Mortality Tradeoff

Numerous studies offer insights into the relationship between income and mortality using both macroeconomic data and individual health and income records.¹⁵ In Viscusi's review, the Chapman and Hariharan study¹⁶ yields an estimate closest to the middle of the

¹³ Sean Altekruse, CDC epidemiologist, Personal Communication (Aug. 20, 1997).

¹⁴ See Centers for Disease Control and Prevention, *Vibrio Vulnificus Infections Associated with Eating Raw Oysters – Los Angeles, 1996*, 45 Morbidity & Mortality Wkly. Rep. 621 (1996).

¹⁵ See Lutter & Morrall, *supra* note 2 and W. Kip Viscusi, *Risk-Risk Analysis*, 8 J. Risk & Uncertainty 5 (1994).

¹⁶ See Kenneth S. Chapman & Govind Hariharan, *Controlling For Causality in*

range of all studies: one statistical death per \$13.3 million income loss (1992 dollars). Their study is based on individual health and income records. Because they account for preexisting health problems, the study is substantially causal, disentangling the impacts of income on health from health impacts on ability to earn income.¹⁷ The individual records clearly indicate whose behavior is described. The only limitation to their analysis is that their data, while extensive, is necessarily incomplete individual health records. Obviously, no data set will account for all preexisting health problems or for deaths that occurred before sampling began. If Chapman and Hariharan's estimate has any bias, the dollar loss necessary to induce a statistical death may be too high. Thus, HHA estimates of premature deaths based on their study may be too low.

Lutter and Morrall reach similar quantitative conclusions about the relation between income and mortality using cross-section time-series data of income levels and mortality rates for 101 countries.¹⁸ Their study suggests one statistical death per \$9.3 million income loss (1992 dollars). Because the Lutter and Morrall study uses macroeconomic data, their estimate is based on a complete accounting of income and mortality. The use of panel data minimizes the possibility of unspecified variables confounding the measured influences.

The most significant problem raised by basing HHA on either the Lutter-Morrall or the Chapman-Hariharan results is that their statistics reflect aggregate averages.¹⁹ Averages may conceal distributional effects or may simply misstate induced fatalities when regulations affect individuals who are not average. Keeney analyzes data from the National Longitudinal Mortality Study to estimate the relationship between income and the annual probability of death. He estimates income-mortality relations for white males, black males, white females, and black females. For each subpopulation, he estimates the relationship as a negative exponential function based on the assumption that

the Link from Income to Mortality, 8 J. Risk & Uncertainty 85 (1994).

¹⁷ See John Mullahy & Jody L. Sindelar, *Health, Income, and Risk Aversion: Assessing Some Welfare Costs of Alcoholism and Poor Health*, 30 J. Human Resources 439 (1995).

¹⁸ See Lutter & Morrall, *supra* note 2.

¹⁹ See *id.* and Chapman & Hariharan, *supra* note 7.

mortality rates fall as income rises, but does so at a diminishing rate. At very high income levels, additions to income no longer reduce the probability of death. The imposed functional form recognizes that the current distribution of income and the distribution of regulatory costs influence mortality probabilities. Keeney accounts for the influence of varying risk preferences and individuals' varying ability to withstand health insults with estimates distinguished by ethnicity and gender.²⁰

We use Keeney's estimates to specify the likely induced number of fatalities.²¹ Anderson et al. report income, ethnicity, and gender characteristics of workers within the oyster industry.²² In the oyster industry, occupations follow ethnic and gender categories; harvesters are mostly white males and processors are mostly black females. Thus, calculated losses incurred by occupation can be interpreted in demographic terms. That is, we calculate baseline income levels and likely income losses incurred by oyster harvesters and processors. Using the functions Keeney estimates, the income calculations reveal increases in fatalities.²³

Estimated Income Losses

Anderson et al. developed an economic impact model to estimate income losses in Gulf regions resulting from control options to reduce morbidity and mortality from consuming *Vibrio vulnificus*-contaminated oysters.²⁴ The model estimates oyster prices and harvesting levels under alternative control scenarios. With estimates of pre- and post-control oyster prices and harvest levels, we calculated the induced direct income losses borne by oyster fishermen.

Oystering communities generally are located in areas with few employment alternatives. Many communities are in remote areas, such as southern Louisiana. Others are in areas with strict zoning protections for wildlife and water sources that restrict commercial development, such as the Florida panhandle. These communities already face economic difficulties that limit re-employment opportunities. Labor market studies show that workers may suffer permanent income losses

²⁰ See Keeney, *supra* note 4.

²¹ See *id.*

²² See Anderson et al., *supra* note 5.

²³ See Keeney, *supra* note 4.

²⁴ See Anderson et al., *supra* note 5.

following job loss, and some workers may remain jobless for many years.²⁵ But, eventually, displaced workers find other employment, even after a period of unemployment and changing occupations. We calculate losses assuming workers would leave oystering if their earnings fell below minimum wage earnings. Thus, losses are the difference between earnings from oystering and minimum wage. In effect, we assume workers are immediately reemployed at minimum wage.

When an outside influence diminishes a region's income, there are additional ripple effects in the region as other economic activities slow in response. In this case, the influence is a constraint on an economic activity, oyster harvesting. Related industries, such as oyster processing and refrigerated transportation, are especially affected. When a control measure is expected to affect a particular locale, regional input-output multiplier models are typically employed to determine the indirect impacts on that region.²⁶ Using county-level oyster harvest data from each Gulf state, Anderson et al. identified where oyster harvesting is concentrated.²⁷ They selected four combinations of Bureau of Economic Analysis (BEA) areas that include these major oyster-producing counties to construct four Gulf oyster regions. For each of the four regions, they incorporated the Regional Input-Output Modeling System (RIMS II) multipliers from the U.S. Department of Commerce in the model. Then, the economic impact and input-output multiplier models were used together to estimate the total income losses.

²⁵ See, e.g., John T. Addison, Douglas A. Fox & Christopher J. Ruhm, *Trade and Displacement in Manufacturing*, Monthly Lab. Rev. 58 (April 1995); Louis S. Jacobson, Robert J. LaLonde & Daniel Sullivan, *Earnings Losses of Displaced Workers*, 83 Am. Econ. Rev. 685 (1993); Lori Kletzer, *Industry Wage Differentials and Wait Unemployment*, 31 Indus. Rel. 250 (1992); Christopher J. Ruhm, *Are Workers Permanently Scarred by Job Displacements?*, 81 Am. Econ. Rev. 319 (1991); Christopher J. Ruhm, *Displacement Induced Joblessness*, 73 Rev. Econ. & Stat. 517 (1991); Daniel S. Hamermesh, *What Do We Know About Worker Displacement in the U.S.?* 28 Indus. Rel. 51 (1989).

²⁶ See, e.g., Cletus C. Coughlin & Thomas B. Mandelbaum, *A Consumers' Guide to Regional Economic Multipliers*, Fed. Reserve Bank of St. Louis Rev. 19 (Jan.-Feb. 1991); Joel R. Hamilton et al., *Economic Impacts, Value Added, and Benefits in Regional Project Analysis*, 73 Am. J. Agric. Econ. 334 (1991); Joel R. Hamilton et al., *Interregional Spillovers in Regional Impact Assessment: New Mexico, Texas, and the Supreme Court*, 25 Growth & Change 75 (1994).

²⁷ See Anderson et al., *supra* note 5.

Estimated Health Transfers

With a harvesting ban, Gulf oyster-related *Vibrio vulnificus* mortality may be reduced. These benefits would be distributed to the extent harvesters distribute and the public consumes Gulf oysters across the U.S., but would be concentrated within an identified “at-risk” population with existing medical risks, including liver disease and immuno-compromising illnesses. The costs of an oyster-harvesting ban would be concentrated in the Gulf oystering communities. The income losses and induced premature mortality would vary for each occupational group.

Table 1 shows the income losses estimated by Anderson et al. and the expected induced mortality trade-offs by occupation.²⁸ After adjusting the compliance costs and wage estimates to 1991 dollars, consistent with Keeney, we evaluate the expected mortality trade-offs in the Gulf states by occupation.²⁹ The total estimated induced mortalities from all income losses lies in a range between eight and twelve deaths. This can be compared to the estimated 17 oyster-related deaths that the harvesting ban would target to reduce.

Table 1
Estimated Income Losses and Induced Mortality (\$1,991)

	<i>Harvesters</i>	<i>Processors</i>	<i>All Other</i>	<i>Gulfwide</i>
Total Income Losses	\$16.9 M	\$13.0 M	\$25.2 M	\$55.1 M
Income Loss Per Worker	\$15,339	\$9,857	\$1.00	na
Mortality Rate Increase				
Per Person	2.82×10^{-3}	2.13×10^{-3}	2.4×10^{-7} - 7.3×10^{-8}	na
Estimated Income-Mortality Trade-off	\$5.4 M	\$4.6 M	\$4.2 - 13.7 M	na
Total Induced Mortality Estimate	3.1	2.8	1.9 - 6.0	8 -12

The first row of Table 1 shows harvesters would lose approximately \$17 million annually and processors would lose \$13 million. Based on the Gulf states' interviews conducted by Anderson et al., absent the ban, harvester's average annual income is \$29,655 (in 1995 dollars), and processing workers average \$20,000.³⁰ A seven-month harvesting ban

²⁸ See *id.*

²⁹ See Keeney, *supra* note 4.

would reduce harvester income by about \$17,200, and processor income by about \$11,600. Based on Keeney's model and parameter estimates for these two gender/ethnicity subpopulations, the annual mortality probability would increase by 0.00282 for harvesters, and by 0.00213 for processors as shown in Row 3 of Table 1.³¹ Row 4 shows that an induced income loss of \$5.4 million for harvesters would result in one statistical fatality, and a loss of \$4.6 million for processors would result in one statistical fatality.

Column 3 of Table 1 indicates the income loss borne by workers of other indirectly affected occupations. Income losses affect suppliers to the oyster industry and lost purchasing power of consumers. Local economies experience reductions in economic activity. For this illustration, we assume that the average 1995 income for all occupations is \$20,970 (\$18,747 adjusted to 1991 dollars) for the southeastern U.S.³² We assume the losses are spread uniformly across the approximately 20 million employed persons in the five Gulf states, with members of each of the four subpopulations incurring the same dollar cost.³³ Thus, we derive four estimates of risk increases. As shown in Row 5 of Table 1, evaluating the incremental mortality risk for all four gender/ethnicity subpopulations results in a range of 1.9 – 6.0 induced statistical fatalities for all other occupations.

If we use the mean income-average mortality estimate from Lutter and Morrall and Chapman and Hariharan, instead of Keeney's estimates, 4.5 premature fatalities are estimated in the Gulf states.³⁴ However, many analysts argue that we should expect a greater-than-average mortality response within a low-income group.³⁵ The 4.5 fatality result must be biased downward as negative impacts accrue to identifiable oystering communities. We follow Keeney's analysis that accounts for income, gender, and ethnicity differences. Using Keeney's

³⁰ See Anderson et al., *supra* note 5.

³¹ See Keeney, *supra* note 4.

³² See U.S. Bureau of Economic Analysis, *Comprehensive Revision of State Personal Income 1969-95*, 76 *Surv. Current Bus.* 48 (1996).

³³ U.S. Bureau of the Census, *Statistical Abstract of the United States: 1996* (116th ed.).

³⁴ See Lutter & Morrall, *supra* note 2; Chapman & Hariharan, *supra* note 7 and Keeney, *supra* note 4. We use the mid-point of \$12.2 million of the range from \$10 to \$14.4 million [1995 dollars].

³⁵ See Lutter & Morrall, *supra* note 2 and Chapman & Hariharan, *supra* note 7.

functions may understate the number of induced deaths as the functions do not account for impacts on dependents of harvesters and processors.

Policy Guidance HHA Offers

This application shows the deminishing health of those incurring regulatory compliance costs, by enacting a harvesting ban. Our results suggest that while a seven-month oyster harvesting ban may avert approximately 17 Gulf oyster-related premature deaths, the income losses that would accompany the ban would induce as many as 12 deaths. In effect, health is transferred from individuals in oyster communities to medically at-risk oyster consumers.

Under conventional cost-benefit analysis, analysts calculate net benefits (dollar benefits *<minus>* dollar costs) and thereby rank diverse types of health and safety programs. Positive net benefits (benefits *<minus>* costs) indicate that a program is a desirable use of public resources, using the benefit-cost paradigm. Alternatively, one could calculate net benefits using HHA (net lives saved *<equals>* lives saved *<minus>* lives lost) and use that number to rank programs and decide which are desirable. For example, a policy that prevents 17 deaths and induces 8 to 12 deaths is inferior to one that prevents 15 deaths but induces only two deaths. Either policy is superior to one that prevents 20 deaths but induces 18.

There are conditions sufficient for this latter notion of net benefits to yield policy guidance that is qualitatively similar to guidance from conventional cost-benefit analyses. Examination of those conditions is worthwhile because they show HHA shares some characteristics with conventional cost-benefit analysis, but offers a unique perspective on the value of public health and safety programs.

Four conditions are sufficient to use HHA to rank programs and to show which programs are worthwhile (offering positive net benefits):

- There is a market failure.
- All deaths count the same.
- Discounting makes present and future benefits and costs comparable.
- Decision makers' only concern is lives — lives lost and lives saved.

Market failure — With both conventional cost-benefit analysis and HHA, positive net benefits of a program exist only if markets have failed. There must be some institutional or informational problem preventing consumers from mitigating a hazard they consider worth addressing (or, would consider worth addressing if they were fully aware of the hazard). Without a compelling argument that markets fail to satisfy consumers' demands for risk reduction, there is no argument for a corrective public action. Whether analysts calculate net benefits using conventional cost-benefit analysis or HHA is irrelevant if there is no demand for a government remedy. In our example, we implicitly assume that consumers are unaware of the risk from *Vibrio vulnificus*. Of course, at least some oyster consumers are aware of the risks as restaurant menus in the Gulf states carry notices about risks. If consumers are aware of the risk and voluntarily accept it, say, because they enjoy raw oysters more than they fear *Vibrio vulnificus*, or because they enjoy risk taking, then there is no market failure.

All deaths count the same — While few are troubled when cost-benefit analyses count dollar benefits just like dollar costs, it is less clear that regulatory decision makers are willing to count lives saved just like lives lost. Graham and Segui-Gomez provide a stark perspective on the importance of policy-induced deaths. In discussing the actuarial evidence of the benefits of passenger-side airbags, they state that a 5:1 ratio of deaths averted to deaths induced is unacceptable.³⁶

Overall, the best estimates are that for every five lives saved by front-right passenger airbags, a life (usually a child) is lost. We are aware of no precedent in the history of preventive medicine where a mandatory measure was sustained with such a poor ratio of lifesaving benefit to fatal risk.

In contrast, a benefit-cost ratio of five, measured in dollars, would say that every dollar spent by the public sector would return \$5 in benefits. It would be difficult to argue against carrying out program with a benefit-cost ratio that high.

Net benefits calculations draw attention to distributional issues when lives are the unit of account. Like airbags, *Vibrio vulnificus* also

³⁶ See John D. Graham & Maria Segui-Gomez, *Airbags: Benefits and Risks*, 5 Risk in Perspective 1 (1997), at 2.

highlights distributional issues. Lives saved by a harvesting ban would be, for the most part, the immune-compromised. Lives lost would include some oyster workers. When dollars are the unit of account, economists usually assume dollars offer the same utility to all. Under this assumption, a finding that dollar-denominated net benefits are positive implies a project is worthwhile from a utility maximizing perspective. If, instead of lives, years of life were the unit of account, HHA could offer similarly straightforward policy guidance, on the assumption that all years of life are equally valuable.

Discounting makes present and future benefits and costs comparable — When calculating dollar-denominated costs and benefits, analysts discount future dollars to present value terms, as if all benefits and costs were incurred immediately. This is necessary because program costs are often incurred before health benefits are realized. The calculation reflects consumers' opportunities as they can readily borrow or loan money, transforming expenses and earnings into current dollars. This calculation gives less weight in decision making to future benefits and costs than to current benefits and costs.

Denominating costs and benefits in lives rather than dollars does not eliminate the problem that costs and benefits accrue at different times. From an HHA perspective, lives lost ought to be expected to fall over time because negative impacts on income will fall; eventually, most individuals who lose jobs will find new jobs. Thus, interventions for which lives lost initially exceed lives saved may reverse over time. Net benefits could not be determined to be either positive or negative without addressing the discount question in these cases. Analysts could apply discounting factors to future lives. However, the calculation requires deciding whether lives saved today are equivalent to lives saved in the future.

Decision makers' only concern is lives — lives lost and lives saved — Lives can be counted in a straightforward way. So far, HHA applications have focused on mortality without explicitly including morbidity. Although some target risk morbidity information may be available, no comparable morbidity and income studies are available. Without this latter linkage, the net public health profile is incomplete. However, even with a complete public health profile, HHA would still be a weaker test than dollar-denominated cost-benefit analysis. The

bottom-line costs that are relevant for HHA are the induced adverse health consequences. These are realized because individuals contract spending on risk reducing activities when they face higher taxes and new regulatory compliance costs. But, as individuals spend only a portion of their income on risk reduction, HHA neglects the negative impacts of dollar losses on all other activities. In effect, programs that HHA indicates are worthwhile could be quite different from programs that pass a dollar-denominated cost-benefit test.

Nevertheless, net lives saved could be used as a measure of net benefits. Calculating net lives saved, analysts could rank diverse health and safety programs, determining which are worthwhile. However, the four conditions that must be satisfied for net lives saved to function in this manner are controversial, and unlikely to be universally accepted. HHA may be of practical significance even when the conditions are not met. Usually, choices involve only the fate of a specific program. HHA provides unique information to these decisions. When programs single out specific subpopulations for special protection, HHA provides a view of the opportunity costs of programs that conventional cost-benefit analysis cannot. HHA reminds program advocates that there are real lives at stake, and not just dollars.

Like any risk assessment or cost-benefit analysis, HHA calculations will usually entail significant uncertainty. The primary uncertainty in our example is the predicted loss of lives from decreased income, which is difficult to measure even after decisions are made. Predicted deaths are too small in number to show up in mortality rate statistics. The exact cause of induced deaths is necessarily undetermined. The decreased death rate from reducing the supply of oysters from the Gulf is less uncertain than the induced death calculation, although the average deaths we have reported contains a considerable amount of variability. A more precise measure of income loss to harvesters, or to related industries could make a major change in our net lives saved calculation, possibly making the positive number negative. Similarly, a more precise estimate of the relation between income and mortality rates could have a major impact on net lives saved. However, these uncertainties are no larger than is typical of most risk assessments or conventional cost-benefit analyses.

Conclusion

Historically, regulatory agencies have interpreted many human health and safety laws to require that hazards be considered individually, without consideration of countervailing risks.³⁷ Legal interpretation guides risk assessment for these hazards, and quantifies only the risk of individual activities or compounds. Decisions following these risk assessments are almost universally concerned with minimizing only the target risk. Recent regulatory reform efforts attempt to promote more cost-effective policies and a greater variety of policy analyses, including the effect of regulatory expenditures on income and mortality.³⁸

The traditional public health approach that focuses on target risks and runs through most law/risk assessment decision criteria serves to improve public health, particularly for risks with minimal uncertainty. The federal government's successful reduction of large quantities of lead in the environment illustrates this approach. However, many small risks now face diminishing marginal returns to expenditures to reduce them.³⁹ When the public sector attempts to control risks for which the cost per target life saved is very high, the reduction in the target risk may not be greater than the increase in the unintended risk.

HHA shares some characteristics with Risk-Risk Analysis. Both presume a social goal of minimizing adverse health outcomes. Both recognize that intervention may have undesirable and unintended consequences. The difference lies in the source each analytical method examines for undesirable and unintended consequences. Risk-Risk Analysis examines how fulfilling government mandates for risk reduction is itself risky. HHA instead examines how diminishing individuals' incomes and opportunities to care for themselves influence the risks they bear. As a practical matter, our example reveals that

³⁷ See John D. Graham & Jonathan Baert Wiener, *Resolving Risk Tradeoffs*, in *Risk vs. Risk: Tradeoffs in Protecting Health and the Environment* (J. D. Graham & J. B. Wiener, eds. 1995).

³⁸ See, e.g., W. Kip Viscusi, *Economic Foundations of the Current Regulatory Reform Efforts*, 10 *J. Econ. Persp.* 119 (1996); W. Kip Viscusi, *Mortality Effects of Regulatory Costs and Policy Evaluation Criteria*, 25 *RAND J. Econ.* 94 (1994).

³⁹ See John F. Morrall III, *A Review of the Record*, *Regulation*, Nov.-Dec. 1986, at 25; Tammy O. Tengs et al., *Five-Hundred Life-Saving Interventions and Their Effectiveness*, 15 *Risk Anal.* 369 (1995).

undesirable and unintended consequences may offset the desirable and intended consequences. In our example, 17 premature deaths caused by ingestion of *Vibrio vulnificus* must be compared with eight to twelve deaths caused by income loss.

Potentially, HHA may point to risk trade-offs that Risk-Risk Analysis cannot identify. When a government regulation calls a halt to the use of a substance, activity, or production method and no feasible replacement exists, Risk-Risk Analysis will not identify adverse health outcomes, even if income levels fall. HHA can help to ensure that risk managers internalize the public health costs of their decisions, particularly in cases with large per-capita costs.

