ISSN 1045-6333

RISK EQUITY

W. Kip Viscusi

Discussion Paper No. 294

8/2000

Harvard Law School
Cambridge, MA 02138

The Center for Law, Economics, and Business is supported by
a grant from the John M. Olin Foundation.

JEL Class: D-63, D-80, J-17, Q-28

Risk Equity

By W. Kip Viscusi*

Abstract

Risk equity serves as the purported rationale for a wide range of inefficient policy practices, such as the concern that hypothetical individual risks not be too great. This paper proposes an alternative risk equity concept in terms of equitable tradeoffs rather than equity in risk levels. Equalizing the cost per life saved across policy contexts will save additional lives and will give fair treatment to risks arising in a variety of domains. Equitable tradeoffs will also benefit minorities who currently are disadvantaged by politically based inefficient policies.

* John F. Cogan, Jr. Professor of Law and Economics, Director of the Program on Empirical Legal Studies, Harvard Law School.

Risk Equity

W. Kip Viscusi*

I. Introduction

The equity consequences of risk regulations have become a formal component of governmental evaluations of risk and environmental policies. Policy concern with environmental justice and environmental equity is perhaps the most visible manifestation of a concern with risk equity. President Clinton issued Executive Order 12898 in 1994 that required agencies to "identify and address…disproportionately high and adverse human health or environmental impacts" on minority populations. In response to this order, the U.S. Environmental Protection Agency established a watchdog office within the agency, the Office of Environmental Equity, to monitor the effects of environmental policies on equity concerns. These developments were also mirrored in the emergence of a large literature dealing with environmental equity and related concerns.[1]

While environmental equity has been the most salient concern, a variety of other forms of equity with respect to risk affect policies not only in the environmental area but across other types of risk regulations. What we mean by fair is more problematic and, in the extreme case, can lead to the ad hoc justification of any specific policy intervention, however expensive it might be. Is it, for example, fair to target a population group that

* John F. Cogan, Jr. Professor of Law and Economics, Director of the Program on Empirical Legal Studies, Harvard Law School, Hauser 302, Cambridge, MA 02138, phone: 617-496-0019, fax: 617-495-3010, e-mail: kip@law.harvard.edu. Paper prepared for University of Chicago Law School conference on benefit-cost analysis, September 17-18, 1999. Helpful comments were provided by Matthew Adler, Eric Posner, Judge Richard Posner, and conference participants.

has been disadvantaged for reasons other than risk, such as poor education, and to provide them with more protective risk regulations to compensate them for their disadvantaged status? Or should we attempt to provide some kind of equal protection irrespective of economic status and, if so, what is it that we mean by equitable protection against risk? Fairness has no well defined guidelines for what is and is not fair and, as a result, this article will explore a wide variety of potential fairness concepts, recognizing that there are quite diverse views as to what does in fact constitute an equitable risk policy.

My concern with risk equity will not be from the standpoint of moral criteria but rather social welfare maximization.[2] In particular, the emphasis is on decision procedures by government agencies, as these procedures function in practice. In a more idealized political world in which there was no use of equity concerns to mask self interested efforts to tilt policies away from welfare maximizing norms, the role of equity might be quite different. Thus, a driving force of much of what follows is that purported equity concerns often serve as the rationale for justifying bad policies.

My most direct experience with such notions of equity came with respect to the siting of the new landfill in Orange County, North Carolina in the early 1990s. The previous landfill site, which was becoming full, was located in a rural area. To promote environmental equity, the policy decision was made to site the new landfill in a manner that would not affect farm uses in the rural areas of the county. The first recommended site was a tract of as yet undeveloped land bordering what was one of the most affluent

---

[1] See, for example, Been (1993, 1995), the Commission for Racial Justice (1987), Hamilton (1993, 1995), and Zimmerman (1994).

[2] This distinction parallels that in the paper by Matthew Adler and Eric Posner, "Implementing Cost-Benefit Analysis When Preferences Are Distorted," in this volume.

suburban areas in Chapel Hill. This landfill site had the additional disadvantage that it was less than 500 yards from my house. While the neighborhood was successful in fighting this misguided notion of environmental equity, the site the county chose instead was not superior from an efficient policy standpoint. The county instead designated a section of the Duke Forest to be used as the landfill. In what was surely an outrageous environmental outcome, the county chose as its landfill site a pristine research forest and nature preserve of the Duke University School of the Environment. The environmental equity in this case was achieved by imposing substantial losses on an educational institution located in the neighboring Durham County and which consequently did not have as much political clout within Orange County as did the local farmers. In this instance, which is by no means unique, environmental equity provided the vaguely defined rationale for a thoroughly misguided and socially harmful policy driven by political interests.

The principal view I will advocate here is that risk equity concerns are almost invariably harmful to public welfare. Within the highly charged political context of policy development, it is almost always possible to conceive of some notion of risk equity to justify even the most inefficient policy interventions. The same kinds of problems are encountered in contexts of traditional economic regulation as, for example, one could justify milk price supports or other regulatory market distortions on the grounds that they provide equitable benefits to the milk producers. All government policies involve transfers of various kinds, some of which may be monetary and others of which may be in-kind. Those who benefit invariably plead that equity demands that they receive the policy benefits. Risk regulation policies typically involve in-kind transfers,

but they nevertheless raise the specter of rent seeking and attendant inefficiencies that one encounters whenever one departs from economic efficiency norms.

The particular equity reference point that I will advocate in Section II is the outcomes achieved by efficient markets. In particular, the outcomes in competitive market transactions involving risk will serve as the standard for what I will consider to be an equitable risk. Because markets for risk do not always exist, there are frequently regulatory interventions for which the efficiency test is benefit-cost analysis. I will explore this concept and its relationship to risk equity in Section III. What people mean by risk equity typically is neither market based nor linked to benefit-cost analysis but rather to some other notion of what kinds of risks are fair and what kinds of risks are not. Section IV examines many diverse concepts along these lines and illustrates why departures from efficiency norms can lead to wildly ill-conceived government policies.

II. The Market Reference Point

The functioning of efficient markets involving risk establishes what I will take as my reference point for equitable risks. Consider a market transaction in which risk attributes of a product are bundled with other product characteristics. Then if the consumer is willing to buy the product the person's willingness to pay for it necessarily exceeds the cost of the product, taking into account all the effects of the product in terms of health and safety risks. Similarly, in the case of jobs, the wages that workers are paid will either equal or exceed the amount that they require to bear the risk associated with the job. These decisions by consumers and by firms in turn create incentives for efficient

levels of safety, the details of which have been explored elsewhere.[3] Because consumer and worker preferences in effect set the price of safety in the market place, the level of product safety and job safety will necessarily reflect these valuations, leading to an efficient level of risk.

Market outcomes have the additional feature that there is also a transfer to compensate individuals for bearing the risk. Purchasers of less crashworthy cars pay a lower price for these products.[4] Houses located near Superfund sites are priced lower than those in safer neighborhoods.[5] A substantial literature has documented the existence of compensating differentials for job risks.[6] Thus, a voluntary transaction necessarily improves the welfare of all participants in the market transaction, making them better off or indifferent with respect to their previous situation.

It is useful to link these market transactions to the basic principles of the Coase Theorem. For job risks and product risks in these market contexts, the individual bearing the risk must be compensated to incur the risk. For pollution situations in which property rights are assigned to the polluter, the outcome of Coasean bargains will provide for efficient levels of risk after the pollution victims pay the polluter sufficiently to decrease pollution levels.[7] While efficient in terms of risk, such situations are not comparable to my market ideal because they make the party bearing the risk worse off because they do not have the property rights and must pay to avoid the risk.

---

[3] See Viscusi (1979) for a more complete description of the functioning of markets for hazardous jobs.
[4] See Atkinson and Halverson (1990) and Dreyfus and Viscusi (1995).
[5] Estimation of the value of life based on this relationship appears in Gayer, Hamilton, and Viscusi (1999). Been and Gupta (1997) explore this relationship and its effect on environmental justice.
[6] For a review see Viscusi (1999).
[7] Efficiency here is in terms of short run efficiency in terms of pollution levels. Long run incentives to enter the polluting industry will be too great if polluters are paid to reduce pollution.

A distinctive feature of market transactions is that people make decisions reflective of their individual circumstances, and firms and other enterprises engaged in market transactions likewise make decisions based on their economic situation. The essential element of markets is that they permit such heterogeneity to play an important economic role. Consider the case of firms with differing costs of providing safety. It is extremely costly to substantially reduce the risks in sawmills and for construction work, whereas making the health and safety risks to investment bankers very small is quite within the realm of economic feasibility. For any given price of safety set through consumer or worker preferences, we will observe higher risk levels at firms where safety is more costly to provide.

The risk heterogeneity of primary interest here is with respect to individuals. Discussions of risk equity typically focus on equity in the risks across people rather than equity in the risks across firms or other institutions. The three principal sources of heterogeneity that will be reflected in market transactions and which should be reflected to enhance economic efficiency are heterogeneity in individual riskiness, heterogeneity in individual willingness to incur risks, and differences in preferences for activities that pose risks. The decentralized individual decisions in the market place permit each of these sources of heterogeneity to be expressed in the market transaction and to be reflected in ultimate risk-compensation outcome.

Consider first heterogeneity in individual riskiness. Individuals' susceptibilities to disease vary, as do their skills. Jobs that require heavy lifting, for example, will be more likely to pose injury for those who lack physical strength. Inspection of accident statistics suggests that there are many important personal characteristics that drive

differences in accident rates. Some of these differences are by gender. Men suffer higher death rates for most causes of death, such as accidents and homicides, though women are more susceptible to pneumonia and risks of diabetes.[8] Age-related differences are consequential as well, as males age 15-24 are particularly prone to being killed in motor-vehicle accidents, and the elderly are particularly susceptible to deaths from falls.[9] Market outcomes exploit this heterogeneity in the riskiness across individuals by, for example, matching male workers in their 20s to physically demanding and risky employment.

A second source of heterogeneity is with respect to people's willingness to incur risk, in particular their willingness to trade off money or other attributes for increases in the probability of some adverse outcome. Individual utility functions for different health states can differ just as can tastes for other goods. One of the most salient risk decisions people make is with respect to cigarette smoking. Not surprisingly, cigarette smokers differ in quite fundamental ways from nonsmokers. Consider the following results for males from Hersch and Viscusi (1998). Compared to nonsmokers, male smokers are 16 percent less likely to wear their seatbelts, five percent less likely to check their blood pressure, and nine percent less likely to floss their teeth. They also are more likely to work on hazardous jobs and, for any given level of job riskiness, are more likely to be injured on these jobs. Moreover, they are more likely to be injured at home as well, incurring roughly double the home accident rate of nonsmokers. Quite simply, smokers are greater risk takers than are nonsmokers, and this willingness to bear risk is manifested across a wide range of personal activities.

[8] See p. 10 of the National Safety Council (1998).
[9] *Ibid*. p. 11-12.

A third source of heterogeneity is that people may have different preferences for activities or jobs associated with risks. Downhill skiing, driving long distances for one's job, and eating red meat all pose various hazards, but they also provide consumptive benefits wholly apart from the risk component that makes these consumption activities attractive to those who engage in them. Even in the case of cigarettes, which is perhaps the riskiest product consumed on a large scale, there is substantial heterogeneity in preferences. Estimates of the elasticity of demand for cigarettes typically cluster in the range from -0.4 to -0.7, indicating a fairly steeply sloping demand curve with some people willing to pay considerable more for cigarettes than the market price. Steepness in the product demand curve indicates substantial heterogeneity in the value consumers place on this product. Differences in the valuation of the consumptive benefits of cigarettes in turn will affect the amount of the health risk people are willing to incur in order to derive the pleasures associated with smoking cigarettes.

The role of heterogeneity is also manifested within situations in which there are differences in the risks that people take. A chief example is that of the labor market, in which workers who have self selected into very high risk jobs have different attitudes towards risks in average risk jobs. For example, estimates of the implicit values of life based on labor market choices in Thaler and Rosen (1976) focused on workers in comparatively high risk jobs that posed an annual fatality risk of one chance in 10,000. The implicit value of life for their sample was $1.0 million dollars (1998: III prices using the GDP deflator). Comparable estimates of the value of life in Viscusi (1978, 1979) for a broadly based sample in which workers faced an average risk of death of one chance in 10,000 yielded estimates of the implicit value of life of $4.9 million. As shown in

Viscusi (1981), this heterogeneity across different groups in the labor market can be estimated explicitly, with the expected relationship that workers who gravitate to high risk jobs exhibit lower values of life than those in comparatively less risky positions.

It is not appropriate to say these value of life numbers reflect monetary amounts of compensation to incur risk, whereas individual utility is a more fundamental concern. Value of life estimates are in fact reflections of individual preferences, and hence utility. More specifically, the marginal rate of tradeoff between wages and fatality risk (i.e., the value of life) equals the difference between the utility of money when alive minus the utility of money after death, where this difference is divided by the expected marginal utility of consumption. This division in effect normalizes the utility differences across people to reflect the rate of tradeoff within their preference structure.

To focus not on tradeoffs but on utility levels has no economic content under standard expected utility theory models. Utility functions are unique up to a positive linear transformation. The level of any person's utility can be scaled up or down arbitrarily. We cannot make valid interpersonal comparisons of utility levels, but we can draw conclusions within individuals. Moreover, greater risk-money tradeoffs as reflected in a higher value of life show that within that person's preference structure safety is more highly valued. Social welfare functions could, of course, choose to weight people's valuations differently. However, my principal theme will be that greater attention to efficiency will foster greater equity than under the current regime in which various equity concepts are avowed concerns.

Heterogeneity in the value of life is also manifested in the correlation between the riskiness of individual jobs and the riskiness of one's other activities. In Hersch and

Viscusi (1990) we found that people who smoke cigarettes and who did not use seat belts while riding in cars exhibited lower implicit values of job injury than did their more safety-preferring counterparts. Evidence in Viscusi and Hersch (1999) indicated that this relationship was extremely powerful. Indeed, smokers' greater willingness to bear risk as well as their greater riskiness for different activities leads them to accept extremely risky jobs for which their total risk compensation is less than what nonsmokers receive for lower risks.

Other forms of heterogeneity in implicit values of life and injury are also well documented. Chief among these is the effect of age.[10] Workers exposed to risks on the job have different durations of life at risk and, as one would expect, the greater the length of life at risk the higher the required compensation will be. Moreover, estimates for a number of data sets suggest that the implicit rate of discount that workers have with respect to years of life lost cannot be distinguished statistically from prevailing rates of interest.

Income levels are also consequential. Estimates of the income elasticity of the implicit value of job injuries in Viscusi and Evans (1990) suggest that the relationship is roughly proportional in much the same way as the present value of lost earnings in a wrongful death suit increases proportionally with one's income. Other personal characteristics, such as gender, also seem to be closely related to the willingness to bear risks, although the failure of many studies to find compensating differentials for job risks faced by female employees seems to be largely due to the failure of these earlier studies to use gender-specific job risk data. As shown in Hersch (1998), women face nonfatal

[10] For estimates of the quantity-adjusted value of life, see Moore and Viscusi (1988) and a series of sequels to this work, which are summarized in Viscusi (1992a).

injury risks just below those of men and have similar wage-risk tradeoffs for injuries, but they are much less likely to be exposed to fatality risks on the job.

The magnitude of the risk involved also is influential. From a theoretical standpoint, as a person's base risk changes one's willingness to trade off money against health risks is altered as the opportunity cost of financial resources is reduced when the base level mortality risk is higher. These base rate effects have been estimated explicitly in Viscusi and Evans (1990), which also explores the role of the magnitude of risk change. The money-risk tradeoff rate is not a constant but in fact diminishes with the extent of the decline in risk for willingness to pay and increases with the extent of the increase in risk for the willingness to accept value.

All these different sources of heterogeneity have been documented empirically and are a reflection of the kinds of flexibility afforded by market outcomes. By matching individuals with risks suited to their preferences and capabilities, market outcomes exploit this heterogeneity in welfare that would be suppressed under the alternative situation in which individuals were constrained.

An immediate policy implication of this result beyond observing the benefits of market transactions is that regulatory interventions through informational regulations such as hazard warnings have much to recommend them. Such policies operate on a decentralized basis and, if the warnings efforts are designed appropriately, can be very effective in making people knowledgeable about risk and in assisting them in their discrete choices of risky activities (i.e., why do they take a particular job or buy a

product) as well as with respect to the precautions they take within these particular activities or product uses.[11]

Consider the possibility of regulating asbestos exposure in the workplace. One possibility is to issue a governmental regulation that limits asbestos exposures in the workplace. Under that scenario, once firms comply with the regulation asbestos exposures will be reduced to a lower level, but there will be no additional compensation to workers bearing the risk unless there is awareness of the asbestos exposure. If there had been such awareness previously, there would have been no need for the regulation since the market processes would have generated efficient risk levels in the absence of intervention.

An alternative to direct regulation of asbestos is to provide hazard warnings to workers. Table 1 indicates the effect of asbestos warnings provided to chemical workers who are told that asbestos would be the chemical with which they now work and that this was a carcinogenic substance. Before seeing the hazard warnings workers thought their annual risk of job injury was 0.09, and rated on the same probability risk scale workers roughly tripled their risk perceptions after receiving the asbestos warning. Some workers would leave the job after being given the warning irrespective of the wage rate they were paid, and two-thirds of them would quit if no wage increase was forthcoming. Only a small fraction of the workers would be willing to take the jobs again in the absence of a wage increase. Overall, these workers exhibit an implicit value of job injuries of $27,846, where this injury scale is with respect to nonfatal job injuries on the job and yields estimates comparable to those found in other studies for nonfatal job risks. What

[11] For evidence on the efficacy of hazard warnings policies and criteria for effective design of such efforts, see Viscusi and Magat (1987) and Magat and Viscusi (1992).

these results suggest is that the role of hazard warnings will lead workers who are particularly unwilling to bear health risks to leave their jobs, while those who remain will generate compensating differentials that will provide incentives for safety comparable to those for well known nonfatal job injury risks.

It is useful to compare the market outcome under informational regulations with that achieved through regulatory standards. Each approach is successful in generating an efficient level of safety assuming, of course, that the risk communication effort is designed appropriately and leads to accurate perception of the risk. However, under the hazard communication approach there is also compensation of the individuals who bear the risk, whereas with regulatory standards in the absence of knowledge of the extent of the risk there will be no such compensation. Moreover, the informational approach provides for more efficient job matching by linking workers willing to bear the health risks up with these jobs with remaining asbestos exposures, whereas regulatory standards in a market in which workers are otherwise presumed to be ignorant will not have this effect. By generating efficient risk levels coupled with compensation for risks, informational regulations yield the two principal benefits of perfectly functioning markets.

To say that informational efforts are potentially beneficial policy interventions does not imply that all warnings policies are desirable.[12] Beneficial information efforts should provide new and accurate risk information in a convincing manner. Many informational efforts fall short on one or more dimensions. In some instances the apparent policy intent is not to inform but to deter certain kinds of behavior. Policies of persuasion that attempt to browbeat individuals into changing their behavior are often

ineffective and are almost invariably undesirable from a policy standpoint. Excessive warnings stimulated by a desire to fend off liability burdens also may distort risk comparisons across products.

Informational efforts also impose costs, particularly in terms of their cognitive demands. As warnings efforts proliferate, problems of information overload may develop. Even within a particular warning difficulties may arise with respect to excessive information or label clutter. Warnings also have important externalities, as they may lower people's perceptions of the risks of products that did not receive a warning.

Warnings resulting from policy mandates have an additional potential disadvantage in that they may displace private efforts. However, informational policies represent a policy area in which diversity is not always desirable. Human hazard signal words such as "danger," "warning," and "poison" ideally should have comparable meanings across different risk contexts. Moreover, the most salient print size and the strongest warning are not always desirable, notwithstanding the pressures of tort liability suits to make warnings stronger. Excessive warnings distort across product risk comparisons. What is needed is a standardized hazard warnings vocabulary, which in theory can result from governmental standards.

What these various caveats suggest is that while warnings policies can be constructive, they can also be flawed. Establishing a potentially beneficial governmental role provides no assurance that the actual intervention will necessarily be welfare enhancing. As with regulatory policies, generally the task is to design efforts that enhance efficiency.

---

[12] See Viscusi (1998) for a more detailed review of sound warnings principles.

III. Benefit-Cost Analysis

The principal economic efficiency norm for policy evaluation is to apply a benefit-cost test to policies. In particular, do the benefits of the policy to society exceed the costs? These benefits are conventionally measured by society's willingness to pay for the benefits, which in the case of risk reduction would be the willingness to pay for the small changes in risk resulting from the governmental policy effort. Market outcomes that generate the same risk levels as would benefit-cost analysis will differ in an important way in that those bearing the risk will receive some form of compensation in terms of higher wages or lower prices for the risk. In the situation of risk regulation coupled with a complete lack of information regarding the risk, there will be no associated compensation. The winners can only potentially compensate the losers under a benefit-cost regime, but in practice compensation is not actually paid. This lack of compensation is a longstanding issue that is prominent in critiques of benefit-cost analysis and whether it is necessarily compelling as a policy assessment framework.

Benefit-cost analysis has played a prominent role in establishing criteria for regulatory policies. Under Executive Order No. 12291, President Reagan mandated that agencies demonstrate that major regulations have benefits in excess of their costs, where this requirement is monitored by the U.S. Office of Management and Budget (OMB). Agencies are, however, not bound by this benefit-cost test in instances in which there is a conflict with the agency's legislative mandate, which is largely the norm among risk and environmental regulation agencies. President Clinton continued this approach through his Executive Order No. 12866, with the major change being that it was recognized that

not all benefits can be quantified in monetary terms and that one should view benefits broadly to encompass all policy consequences of significance.

The experience under these benefit-cost regimes has been quite mixed and does not seem qualitatively different from the outcomes in the Carter Administration, which did not have a benefit-cost test but instead quantified benefits, costs, and cost-effectiveness. As I indicated in Viscusi (1992a), the OMB has never been successful in blocking a regulation with a cost per life saved below $142 million per life. This level is more than an order of magnitude of greater than what is sensible based on implicit values of life reflected in market decisions. The result has been that many regulations promulgated have inordinately large costs per life saved.

Table 2 summarizes the costs per life saved for regulations of different regulatory agencies. Omitted from this group are governmental efforts that do not require the promulgation of formal regulations, such as the hazardous waste cleanup program known as the Superfund effort. This major program by the Environmental Protection Agency (EPA) generates a median cost per case of cancer across the cleanup sites of $6 billion per case, which would put it among the most expensive items in Table 2.[13]

What one should use as a cutoff for the appropriate cost per life saved depends on the methodological approach. Historically, government agencies had used the present value of lost earnings as the value of life measure, or what agencies termed the "cost of death." In my 1982 analysis prepared to settle the dispute between OMB and the Occupational Safety and Health Administration (OSHA) over the proposed hazard communication regulation, which had been appealed to then Vice-President Bush, I

[13] The source of this estimates is Hamilton and Viscusi (1999). Moreover, even this estimate understates the actual cost per cancer case since many risk and exposure assumptions are unrealistic.

introduced the value of life methodology based on the willingness to pay estimates derived from labor market behavior.[14] Since that time, agencies have widely adopted the value of life methodology, which has also been endorsed by OMB, but the particular estimate of the value of life used by the agencies may differ. Most importantly, the value of life benefit estimate is not binding on policy judgements because of the restrictive nature of agencies' legislative mandates. Taking a $5 million value of life as a rough cutoff for cost-effective policies, in Table 2 all policies above the 1984 benzene emission standard costing $4.1 million per life saved would pass a benefit-cost requirement and all policies beginning with the ethylene dibromide EPA regulation in 1991 costing $6.8 million per life saved would fail a benefit-cost test.

Asbestos is a particularly noteworthy target of regulatory action in that it has been subject to increasingly inefficient regulations as public pressures mounted in response to the wave of asbestos litigation stemming from exposures in the shipyards in World War II and thereafter. The cost per life saved for asbestos regulations rose from $9.9 million in 1972 to $88.1 million in 1986, with an even more expensive EPA regulation in 1989 at $131.8 million per case of cancer averted.

One quite reasonable notion of risk equity is that if society is homogeneous in its attitudes toward risk that agencies should equalize the marginal cost per life saved across regulatory programs. Doing so will maximize the number of lives saved for any given cost amount. Table 2 present average costs per life saved rather than marginal costs per life saved. Moreover, in some cases the policy benefits occur in discrete jumps, such as the deaths averted from aircraft floor emergency lighting so that marginal tradeoffs are

[14] This analysis is discussed in Viscusi (1992a) and is based on W. Kip Viscusi, "Analysis of OMB and OSHA Evaluations of the Hazard Communication Proposal," report prepared for Secretary of Labor

not pertinent. However, if society wishes to treat exposures to risk equitably under the criteria specified above it should attempt to spend up to the same marginal cost per life saved amount for different agencies, where we abstract for the time being from the role of population heterogeneity. Thus, a more meaningful and compelling risk equity concept is to have equity in terms of the cost per life saved rather than equity in terms of risk outcomes. Equitable tradeoffs consequently become the reference point for risk equity measurement.

There are of course legitimate sources of heterogeneity, but agencies do not recognize them. Consider first the influence of the income of the person protected by the regulatory policy. More affluent individuals will have a greater willingness to pay for protection from health hazards. This issue arose with respect to a report I prepared for the Federal Aviation Administration (FAA) in 1991. The average passenger on a U.S. airline in 1989 had a median income level of $32,480, which is about 1 ½ times the average income level in a representative sample of workers in value of life studies at that time and double or more the income levels of workers confined to particularly high risk jobs. Should the FAA be permitted to use a higher value of life for airline safety policy than the rest of the U.S. Department of Transportation uses for valuing improved guard rails, automobile safety, and other matters? The rationale is that recognition of these income differences reflects the variations in individual willingness to pay for safety, with the counterargument being that this discrepancy creates a form of inequity in terms of the degree to which we are willing to protect people in different income groups. Recognition of these differences leads to a comparably higher willingness to pay for a statistical life saved through airline safety as opposed to other programs of the U.S. Department of

---

Raymond Donovan, March 15, 1982.

Transportation. However, the FAA's use of a higher value of life was not a transfer to more affluent airline passengers. Mandating higher safety levels would boost airline costs and ticket prices. The Secretary of Transportation refused to recognize this heterogeneity that the FAA had sought and chose instead to treat all lives symmetrically, irrespective of differences in willingness to pay. This approach creates equity in terms of benefit valuation but in effect serves as a form of income redistribution to people who do not value the risk reduction policies as greatly.

The airline example becomes a bit more complicated if there is a mixture of income groups on the plane. Suppose that half the passengers value their lives at $8 million and half value their lives at $4 million. Use of an intermediate value of $6 million will lead the poorer passengers to pay more for safety than they would like and the richer passengers to buy less safety than they like. The outcome is efficient on average, but unfortunately airline safety policies do not permit recognition of such heterogeneity when all passengers face identical risks. A situation in which people pay more for safety than they might like individually is also not unique to this example. The bulk of the regulations in Table 2 impose costs well beyond what people would spend on these efforts if government officials chose policies reflecting their preferences instead of the excessive cost levels now being imposed by regulatory efforts.

Recognition of heterogeneity in benefit values can often prevent clear-cut inefficiencies. Suppose that public parking facilities are valued greatly in urban areas, whereas improved erosion control is valued in rural areas. Few would suggest that it is sensible to spend as much per capita on parking structures in rural areas and that we spend the same amount on preventing soil erosion in all locales. Rather, public policy

efforts are targeted where they benefit people to the greatest extent, where the value of these benefits is the willingness to pay for the benefit which, in the case of risk reduction policies, varies by income group.

An additional noteworthy feature of individual willingness to pay for risk reductions is that there is heterogeneity according to the length of life at risk. However, government agencies currently suppress this heterogeneity and value all lives equally. Such symmetry is a form of risk equity in terms of lives, but is one's remaining lifetime a sensible unit of measurement for equity? Current policies are not equitable with respect to the quantity of life at risk.

Controlling for the discounted expected remaining life years is a useful measure to explore for lifesaving efforts, but it is not always compelling. Does, for example, a person's value of life peak at birth, or does education and training boost this value? Similarly, once many important lotteries of life are resolved, such as those affecting income level or societal contributions, the value of life may be quite different. Examining longevity effects is often instructive as policies benefiting people with only a few months to live are less attractive than those benefiting similarly situated people with greater lengths of life at risk.

Adjustments for the quantity of life often have a substantial influence. The final column of Table 2 presents the cost per normalized life saved. This normalization adjusts the lives lost to be equivalent in duration to the fatalities resulting from accidents based on the discounted loss in life expectancy. These efficacy numbers indicate that for health-oriented regulations, such as those affecting cancer for which there is a substantial latency period as well as less quantity of life saved when illnesses are prevented, there is

a substantial increase in the cost per life saved. The asbestos occupational exposure limit in 1972, for example, had a cost per life saved of $9.9 million, but once the estimates are adjusted for the quantity of life saved, the cost rises to $24.7 million per accident equivalent life saved. This effect is more general throughout the table as the cancer reducing policies greatly diminish in attractiveness compared to those preventing accidents.

The current practice of not making distinctions in terms of the kinds of lives saved creates major risk inequities. Lifesaving policies extend lives but do not confer immortality. The result is that efforts that save very little in terms of life expectancy divert resources from programs that could have a major life expectancy effect. A benefit-cost approach in which individual heterogeneity is explicitly recognized in determining benefit levels would prevent these inefficiencies, which are a form of inequity.

The principal counterargument to efficiency-based policy approaches is that they will penalize minorities. Indeed, the most salient risk equity concern has focused on environmental justice, which in turn has been stimulated by claims that hazardous waste sites disproportionately harm minorities. Whether this disproportionate harm actually occurs will be explored below, but the principal issue with respect to risk equity as I have defined it is not whether minorities face greater risk but whether they would fare particularly badly under a benefit-cost regime.

To explore this issue, Hamilton and Viscusi (1999) examined the consequences of moving to a benefit-cost test for the cleanup of Superfund sites. At present, the mean minority percentage at the sites remediated under current policy practices is 17 percent. What would happen to the minority percentage if one applied a benefit-cost test requiring

that the cost per case of cancer averted not exceed $5 million for the cleanup to be justified? Table 3 summarizes those policy consequences. For the reasonably significant sites with cleanup costs greater than $5 million (and consequently at least one expected case of cancer prevented if the site passes a benefit-cost test), the mean minority percentage at the site ranges from 32-39 percent depending on whether one recognizes other legislative constraints affecting cleanup decisions. For the very inexpensive site cleanups with a cleanup cost under $5 million, the mean minority percentage ranges from 17-34 percent. However, one only obtains the low 17 percent figure if one also imposes the influence of cleanup requirements relating to other environmental policies in the absence of a benefit-cost test. If one relied solely on benefit-cost analysis without any other legislative or regulatory constraints, the minority percentages affected by cleanup would be 39 percent for expensive cleanups and 34 percent for less expensive cleanups, where in each case the minority percentage whose welfare is improved by the policy is at least twice as great as the minority percentage affected by current cleanup actions. Note that with an inefficiently high cost per cancer case prevented cutoff of $100 million that the minority percentage in Table 3 drops.

These results are not an aberration. They can be traced to two sets of influences. First, what does in fact drive Superfund cleanup decisions is political power. Sites located in areas where there are influential populations are targeted for more vigorous and more expensive cleanup efforts than are areas with less political clout, which are disproportionately those where there are larger minority populations. Reliance on a benefit-cost test consequently equalizes the playing field across different population

groups, enabling there to be true risk equity in terms of the cost per life saved rather than having policies driven by political power.

A second set of factors contributing to the disadvantaged status of minorities under current procedures is that a variety of risk equity notions have crept into policy design and evaluation. Risk analysis procedures throughout the federal government embody a variety of distortions all intended to reflect a kind of risk equity, but which push away from a benefit-cost norm and impose substantial losses on society, particularly upon the minority groups who are most likely to be harmed by hazardous exposures. These influences will be explored below.

Minorities would benefit if policies gave benefits to that group the same weight as benefits to the white population. In effect, they would have the same willingness to pay value for benefits as non-minorities and consequently receive the same weight. In a more refined policy regime, policy makers might move beyond equalizing the cost per life saved across groups and policies but instead recognize that the value of life increases with one's income, lowering the benefit accorded to minorities. However, following the airline safety example, one might recognize the role of income differences only if people receiving more benefits pay for these additional benefits in some manner. This payment could be direct, as through airline ticket prices, or could be through a higher overall tax bill. Moreover, consistent with concerns arising with respect to Hicks-Kaldor compensation criteria, one could assess the entire spectrum of policies and the payments groups make toward government policies to assess their overall equity. In the absence of such distinctions, application of a uniform value of life will serve as an implicit form of income redistribution.

IV. Alternative Risk Equity Measures

Absolute Risk Levels

If one were to envision a risk-based measure of risk equity, perhaps the most natural measure would be the absolute risk that a person faced. Thus, for any given age level one would focus on the mortality risk. Taking a broader perspective in recognizing the effect of different activities on one's distribution of mortality risks over the lifetime, one might focus on one's incremental mortality risk at different ages or the total effect on life expectancy.

Cigarette smokers are certainly on the high end in terms of their current absolute risk levels. Smoking cigarettes imposes a lifetime risk of premature mortality from smoking of 0.18-0.36, and it shortens one's life expectancy by 3.6-7.2 years.[15] What would be the effect of recognizing that smokers already have very high risks to their lives from their smoking activity? Should these groups be given preference with respect to hazardous waste cleanup, job safety, and other practices? Alternatively, are we necessarily required to reduce smokers' risks to those of nonsmokers in a pursuit of risk equity? Must we ban smoking? If the latter prohibition is mandated, does it also extend to banning high fat foods, mandating a daily exercise regimen, and driving large crashworthy cars? Similarly, should we always give priority in risk regulation policies to those who live in high crime areas because their residential exposures put them at the upper end of the personal risk spectrum?

Risk regulation policies have largely been unconcerned with absolute risk levels. The base mortality risk level of populations at risk seldom arises as a concern at all.

What policy makers focus on instead is the incremental risk from a particular source of risk, whether it be the environment or hazardous products. Any meaningful notion of risk equity, however, presumably should be grounded in the absolute risk level of the individual rather than focusing on incremental risks since otherwise there will be clearcut inequities in what is of consequence to people's lives, which is the total risk they face.

That having been said, it would not be wise to interfere with informed private choices to bear risk. The appropriate policy objective is maximization of expected individual welfare, not risk minimization. Ultimately, a concern with risk levels alone as the policy objective will divert attention from more fundamental welfare principles and lead to interference with economic decisions that should be unconstrained.

Incremental Risk Levels

The policy focus with respect to risk equity is almost invariably on the incremental risk associated with a particular risk exposure. In some instances, the emphasis is not even on a particular class of activities (e.g., all pollution exposures) but rather on a specific source of risk (e.g., risks from a single emissions source). While absolute risks may be a more sensible concern if risk level equity is the policy objective, in practice it is particular incremental risks that drive policy.

Suppose our objective is to equalize risks from different sources so that we all face the same risks from consumer products, jobs, and types of environmental risks. Is this in fact feasible? Floods are more likely to affect the eastern states, with the most severe tallies of flood deaths over the past two decades being in the Appalachians, mid-

[15] For supporting data see Viscusi (1992b), pp. 70 and 80.

Atlantic, Pennsylvania, West Virginia, Virginia, and northeast areas.[16] Do we really want to equalize the floods risk in these states with that faced by residents in arid states such as Arizona? Similarly, heat wave deaths in Chicago hold the fatality record, but would we want Chicago residents to face the same risk of death from heat waves as do people residing in Jackson Hole, Wyoming?[17] Hurricanes are much more likely to threaten residents on the Atlantic Coast, particularly in the southeast, than they are to affect the population of Kansas, which is more susceptible to tornadoes.[18]

Attempts to equalize the risk from different sources are no more sensible than trying to equalize these incremental risks from classes of natural disasters. The reason why it is not sensible to equalize risks from natural disasters any more than it is to equalize the risks from air pollution, hazardous waste, or job risks across different occupations is that there are different costs to reducing risk to low levels in these different contexts. Ultimately, any plausible objective for government policy must incorporate both costs as well as what is delivered for these costs, which are the risk reductions or the benefits achieved.

Focusing on incremental risks as the equity norm takes on additional irrationalities with respect to specific misguided notions of risk equity that have arisen. Within EPA hazardous cleanup efforts, the focus is on individual risks rather than population risks. Thus, any actual or hypothetical individual risk exposure to a cancer risk of at least one chance in 10,000 requires mandatory cleanup of the risk, and the agency has discretion to mandate a cleanup for risks up to a lifetime risk level of one in a million. The focus on individual risks rather than population risks stems from the risk

[16] These statistics on flood deaths are from page 22 of the National Safety Council (1998).
[17] In 1995, 465 people died in a heat wave in Chicago. See National Safety Council (1998), p. 22.

equity notion that no particular individual should be exposed to an incremental lifetime risk exceeding a particular amount, in this case one in 10,000. What this seemingly innocuous risk equity requirement does is drastically distort policy practices. Risks where there is some potential hypothetical future exposure, which may or may not materialize, receive the same policy weight as do current risks to large populations. Indeed, under current policy practices EPA does not even consider the size of the exposed populations. Moreover, empirically the population density has no statistically significant effect on Superfund cleanups.[19]

We are consequently faced with anomalies where EPA is mandating ambitious cleanups such as that noted by Justice Stephen Breyer:

> Let me provide some examples. The first comes from a case in my own court, *United States v. Ottati & Goss*, arising out of a ten-year effort to force cleanup of a toxic waste dump in southern New Hampshire. The site was mostly cleaned up. All but one of the private parties had settled. The remaining private party litigated the cost of cleaning up the last little bit, a cost of about $9.3 million to remove a small amount of highly diluted PCBs and "volatile organic compounds" (benzene and gasoline components) by incinerating the dirt. How much extra safety did this $9.3 million buy? The forty-thousand-page record of this ten-year effort indicated (and all the parties seemed to agree) that, without the extra expenditure, the waste dump was clean enough for children playing on the site to eat small amounts of dirt daily for 70 days each year without significant harm. Burning the soil would have made it clean enough for the children to eat small amounts daily for 245 days per year without significant harm. But there were no dirt-eating children playing in the area, for it was a swamp. Nor were dirt-eating children likely to appear there, for future building seemed unlikely. The parties also agreed that at least half of the volatile organic chemicals would likely evaporate by the year 2000. To spend $9.3 million to protect non-existent dirt-eating children is what I mean by the problem of "the last 10 percent."[20]

---

[18] For documentation, see "The Wizard of Oz" (1939).
[19] These and other descriptions of the operation of the Superfund program are based on the empirical analysis in Hamilton and Viscusi (1999).
[20] See Breyer (1993), pp. 11-12.

Justice Breyer's experiences are not an outlier, as Superfund cleanup efforts are not grounded in protecting populations but in the reduction of individual risks, hypothetical or real. Risk equity in terms of reducing individual risks is the guiding principle, not total risk reduction benefits or benefit-cost tradeoffs. This practice disproportionally harms minority populations. Minorities are particularly likely to be densely concentrated around hazardous waste sites. Indeed, for sites in which there are risks to existing populations from current risk exposures, 45 percent of the population within one-quarter of a mile of Superfund sites are minority populations. Indeed, the main source of risk inequity to minorities is not that there are more hazardous waste sites located in minority neighborhoods. In fact, the average white population located within one mile of the Superfund site is actually greater than for minorities. In particular, the average white population figure across all Superfund sites on the National Priorities List is 86 percent, which exceeds the white population percentage of 80 percent.[21] However, when minorities are present they are often present in much greater numbers and are concentrated either directly on site or particularly close to the Superfund sites. Somewhat incredulously, EPA completely ignores the magnitudes of the population exposed and the total number of cancer cases to be prevented by any hazardous waste cleanup. It focuses instead on the risk equity concept of individual risks, which disadvantages existing populations who receive no weight for their greater numbers and no weight for the fact that these risk exposures now exist. Hypothetical risk exposures that may never exist and which are never discounted to present value receive the same weight as do current real risks. These individual risk equity practices consequently serve as one of the contributors

[21] See Hamilton and Viscusi (1999), p. 168.

to the neglect of minorities under current practices that nominally preach a commitment to environmental equity.

There is also inconsistency in terms of how the incremental risk levels are handled in reference to the policy targets. Suppose that a risk meeting the one in 10,000 lifetime risk is the trigger for cleanup. As part of the cleanup, EPA may mandate extremely stringent policy options that reduce the post-remediation risk to 10^{-8} or 10^{-9}. However, the result is that the post-cleanup level of the risk will be much lower than the risk threshold of 10^{-6} which EPA has set as a cutoff where cleanup should not be pursued. If in fact risks greater than 10^{-4} require cleanup, risks between 10^{-4} and 10^{-6} can potentially be targets for cleanup, and risks smaller than 10^{-6} should never be addressed by EPA cleanup, will there not be substantial inequities created in terms of the incremental risk by reducing the risk level at sites receiving cleanup to levels 100 or 1,000 times safer than the risk cutoff at which EPA stipulates that no cleanup should be undertaken? Quite simply, these individual risk policy guidelines that purport to be a form of risk equity are not a sensible basis for policy.

The concern with equity for hypothetical future generations of risk exposures becomes particularly problematic with respect to risks far into the distant future.[22] Recent studies of the storage of nuclear wastes indicate that there could be corrosive effects on the buried wastes beginning in the year 102010, with potentially significant radioactive exposures for nearby farmers in the year 312010.[23] Should risks at least 10,000 years from now merit the same concern as risks to current populations? As a policy matter, some federal agencies such as EPA do not discount risk effects to present

[22] These issues are explored in detail by John Broome (2000).
[23] For supporting discussion, see John Christensen (1999).

value so that deferred influences matter as much as current effects. From an economic standpoint, discounting is warranted because what is being discounted is society's willingness to pay for the benefits, not deaths. Coupling this lack of discounting with a practice of ignoring the size of populations affected creates a preposterous basis for policy in which the potential of future technologies to reduce these risks becomes less consequential than our current risk conservatism.

If our concern with incremental risk equity is real, should we not also have the same concerns across countries as well? Indeed, there have been some proposals espoused by labor unions and other groups that the United States not import any goods produced in a manner that does not conform with U.S. job safety and environmental standards and that the Unites States not export any goods that do not meet U.S. safety standards.[24]

Such notions of risk equity will engender substantial inefficiencies. Less developed countries have much lower income levels than in the United States, so that forcing them to adhere to U.S. safety and environmental practices will make these societies worse off, with their attendant adverse mortality effects. Is it, for example, realistic to require that China comply with current U.S. environmental pollution standards and that manufacturing production in Africa and Indonesia adhere to U.S. safety standards? It is only because of our greater affluence that we have been able to afford such efforts, as the preference for risk reduction increases substantially with societal income. Banning the import of these goods is little more than a form of disguised protectionism, as the main force that will promote economic well being and ultimately

[24] For an academic advocacy of this position, see Ashford (1976).

the health of less developed countries will be international trade rather than embargoes on their products if they do not meet our lofty risk and environmental standards.

The prohibition of exports of hazardous goods is likewise ill-conceived except perhaps for situations in which there will be considerable misperceptions arising from goods made by U.S. companies that do not in fact meet U.S. safety standards. Requirements that U.S. exports meet U.S. safety standards create economic harms to U.S. workers. A salient case where these practices have been of concern is with respect to pharmaceutical products. Many drugs are approved for use in western Europe before approval is given in the United States by the Food and Drug Administration (FDA). By not permitting firms to manufacture and export goods that do not meet U.S. pharmaceutical safety requirements, the restrictions in effect force these operations overseas. Other countries with different medical establishments and different criteria for approval might legitimately choose to permit the use of the drug in that country even though it has not been approved by the FDA. Indeed, even with the U.S. there has been a long-standing complaint about the drug approval lag times. Policy efforts periodically attempt to accelerate drug approval times in recognition of the often tardy process by which life-saving drugs reach the market.

Actual Versus Perceived Risks

In promoting risk equity, should our concern be with the risks that people actually face or the risks that people perceive that they face? Put somewhat differently, should we equalize the mortality risk to individuals or their fears of these mortality risks? Let me make my biases clear at the outset. The objective of government policy in my view

should be to reduce objective risks to populations and to generate actual improvements in health rather than foster illusory increases in well-being.

Policy discussions with respect to protecting populations, particularly with respect to hazardous waste exposures, often suggest that the emphasis should be on perceived risks rather than real risks. It is fear of hazardous waste that drives these programs, as hazards from chemical wastes rank first in the public's concerns for environmental risks even though the actual risks are quite small in most instances.

Suppose that the government had a choice between equally costing policy options for cleaning up wastes in two different towns. In Happyville there are no actual cases of cancer to be prevented but people believe that 100 cases would be prevented through a hazardous waste cleanup. In Blissville, people are completely ignorant of any risks, but hazardous waste cleanup efforts will reduce 100 cases of cancer. If cleanup efforts in each town have the same cost and if we could cleanup only one of the sites, which should we pick? Some scholars suggest that the choice is not clearcut.[25]

The example discussed above is based on one that I developed as part of an exchange I had with Paul Portney on a panel at the American Economic Association meetings. Portney's example is Happyville, and my counterexample was Blissville. Current policy practices would support cleanup of Happyville. In my view, failure to clean up Blissville is a form of statistical murder in which lives are sacrificed to focus instead on illusory fears.

Proponents of promoting risk equity through addressing perceived risks rather than actual risks often defend their position by suggesting that in a democratic society the government should be responsive to the preferences of the citizenry. However, if these

preferences stem from erroneous probabilistic beliefs, then they should be overridden. For much the same reason that we intervene when people underestimate the risk and buy products that are overly dangerous, we should also not succumb to irrational political pressures that lead us to institutionalize private irrationalities.

Current policies are affected by a curious asymmetry. If people underestimate the risk, policy makers rush to intervene to alleviate the market failure. If people overestimate the risk, creating pressures for wasteful interventions, policy makers defend their interventionist zeal by claiming that in a democracy citizen preferences must be respected. However, what is at stake is not preferences, or the shape of individual utility functions. What is at issue is the underlying probabilistic beliefs which may be quite erroneous and should not receive deference when designing policies.

Is there nevertheless some set of circumstances in which the government should intervene, such as when alarmist responses to risk depress property values? In many instances all that is at stake is transfers across parties. Property owners will be made better off if a hazardous waste cleanup eliminates a feared, but non-existent risk. All that should count from an efficiency standpoint is the attendant efficiency loss from failing to develop the land to its best use.

Risk Characteristics

Often the policy concern is not with the overall risk or even the incremental risk but rather with the type of the risk. Thus, the risk equity notion is that there should be

[25] See, in particular, Portney (1992).

limits on particular classes of risks. The differing treatment of synthetic and natural chemicals is symptomatic of this concern with risk characteristics.[26]

Are synthetic chemicals in fact more dangerous? While some may be, as a general rule synthetic chemicals are not necessarily more dangerous. An examination of a large sample of 365 chemicals indicates that synthetic chemicals pose a lower risk as measured by the TD_{50} value, which is the amount of the chemical needed before 50 percent of the rats in the sample develop tumors as a result of exposure. Other measures of the carcinogenicity of synthetic and natural chemicals for the sample of 365 chemicals yield similar results. However, synthetic chemicals are much more likely to be regulated, particularly by the FDA. The nature of this bias stems from the bias against novel risks created by synthetic chemicals as opposed to existing risks posed by natural chemicals. No measure of risk potency account for the differential regulatory bias, as the underlying risk equity concept driving policy is not even to equalize the risk in any meaningful sense but rather to eliminate the class of risks associated with synthetic chemicals.

Similar kinds of biases seem to arise with respect to health versus safety risks. As the data in Table 2 indicate, the cost per life saved is especially great for cancer reduction policies, where this bias is particularly strong once one adjusts for the length of life lost. To the extent that accidents are more familiar and often involve an element of volition, whereas the health outcomes are much more mysterious in terms of their cause, there may be a form of irrationality that creates pressures for health risk regulation. The relative inadequacy of market forces alone cannot explain this differential emphasis since one would be able to reduce health risks more cost effectively than safety risks if markets were more prone to failure for heath hazards, which they may well be.

[26] The data to be described below are drawn from pp. 86-88 of Viscusi (1998).

Another class of risks that has merited particular policy attention is with respect to involuntary risks as compared to voluntary risks. As noted in the discussion of market behavior, the self-selection of people into voluntary risks will lead the mix of individuals exposed to these risks to have a lower value of life. These values affect willingness to pay values and hence total benefit estimates. Some might suggest that we would go beyond these efficiency related effects and place additional emphasis on eliminating involuntary risks. The stringent controls emerging throughout the country to limit exposures to environmental tobacco smoke indicate the substantial concern with involuntary risks as compared to risks that we knowingly incur. Voluntary risks have the additional advantage of providing some compensatory benefit, such as wages for a risky job, whereas involuntary risks do not. Striking an appropriate balance between the welfare of those affected by involuntary risks and the welfare of those who will be harmed by regulating such risks can be achieved by treating these effects symmetrically using benefit-cost analysis. Current policy practices often view the prevention of involuntary risks as a trump card that should dominate all other policy concerns.

V. The Costs of Risk Equity

The efficiency norm that serves as the point of departure for risk equity concerns can take on several different levels of refinement. At the most basic level one could equalize the marginal cost per life saved across different policies. People exposed to various sources of risk in different contexts would receive the same weight, unlike the current regime in which agencies differ quite starkly in the stringency of their risk regulations.

The first level of refinement would be to recognize that policies to extend life have quite different affects based on the quantity and quality of life at risk. While much remains to be done in refining these economic valuations, evaluating the cost per discounted life year of policies would provide an index of some of the more salient policy concerns. The current approach of ignoring length of life issues creates inequities by valuing the life of a person with advanced respiratory disease and a six month life expectancy the same as a healthy person with a forty year life expectancy.

Recognition of differences in willingness to pay based on income and attitudes toward risk would be the next level of refinement. Such recognition of heterogeneity in values might be most readily accepted in contexts for which there was an actual transaction in which the beneficiaries of the regulation pay for the benefits they receive. The closer the regulatory context can simulate a market structure, the more easily one can use a market efficiency reference point. If there is no payment extracted and some groups with high willingness to pay benefit disproportionately, the policy challenge is to ensure that the entire package of policies and taxes is equitable.

Risk equity as achieved through the operation of voluntary transactions in competitive markets leads to efficient safety levels as well as compensation of those bearing the risk. Hazard warnings that foster such market operations consequently rank very high in terms of their promotion of risk equity. More general regulatory policies grounded in benefit-cost criteria also achieve efficient levels of the risk and can recognize the kinds of diverse concerns to the economic benefits achieved by markets, including factors such as the heterogeneity in individual riskiness and differences in attitudes toward risk, as well as differences to the length of life that is at risk.

Even a simplified benefit-cost norm that abstracts from individual variations in willingness to pay is a more compelling equity rationale than that currently advocated under the guise of environmental equity. The efficiency norm is to equalize the marginal cost per life saved across all efforts, adjusting for factors such as the quantity of life at risk. All lives count equally. Moreover, lives saved by job safety policies count the same as those saved through safer highways or decreased pollution. People harmed by risks from a particular source would not receive differential policy emphasis, as they do now. The equity measure I advocate is to equalize benefit-cost tradeoffs, not just risk levels. The cost-effectiveness equity measure recognizes that risk policies involve both benefits and costs. Current equity practices ignore costs altogether. Instead, they seek to equalize incremental risks, perceived risks, potential individual risks, or some other risk-based measure.

Analysis of the consequences of using benefit-cost tests for choosing hazardous waste site cleanups indicates that the tradeoff between efficiency and equity is in fact a false dichotomy. Minorities would fare much better under a benefit-cost regime than under the current EPA cleanup policy strategy, which purports to advance environmental equity. Notwithstanding the agency's politically correct declarations, the driving force behind hazardous waste cleanup is the political clout of the affected populations. The powerless, the disenfranchised, and the less politically sophisticated fare much worse under the current regime than they would if policy choices were driven by evaluation of policy benefits and costs. Benefit-cost analysis equalizes the political playing field so that what has merit is the risk consequences of the policy, not the political power of those affected. Benefit-cost tests in effect endow minorities with equal standing that they do

not otherwise have within the context of our current regime of politically driven risk regulation policies.

Notions of risk equity that permeate the federal regulatory regime include more than just an avowed concern with the well-being of minorities. For example, there are also efforts to ensure that no particular individual is exposed to too high a level of risk from a particular type of risk exposure. Equity in the sense of constraining risks not to be too great would seem to be an innocuous requirement. However, the policy emphasis on individual risks, many of which are hypothetical risks to speculative future populations, diverts our risk regulation resources away from actual risks to large populations. Since minorities tend to be more densely concentrated in more polluted areas, this policy emphasis creates a discriminatory bias against minorities.

More generally, exploration of the various risk equity concepts suggests that there is no salient risk equity measure to serve as a meaningful reference point. There is almost always some notion of risk equity that can be expounded to justify worthless risk regulations. We purportedly need to spend these funds to protect minorities, to ensure that farmers or those in high risk locales are not at risk, or to eliminate the unfairness of involuntary risks. Ad hoc equity justifications can always be mustered because unlike efficiency norms there is no well defined equity standard.

Consideration of a variety of risk equity approaches that are embodied in risk regulation policies suggests that there are often huge inefficiencies accompanying such misguided equity norms, the extent of which are reflected in the $6 billion median cost per case of cancer averted through hazardous waste cleanup efforts, which do not even advance the interests of minorities. More generally, almost all job safety and

environmental policies have squandered our economic resources. The price that we pay for our equity illusions is thousands of lives that could be saved by basing regulatory policies on efficiency norms.

References

Adler, Matthew, and Eric Posner. 2000. "Implementing Cost-Benefit Analysis When Preferences Are Distorted," Journal of Legal Studies, in press.

Ashford, Nicolas. 1976. Crisis in the Workplace: Occupational Disease and Injury (Cambridge: MIT Press).

Atkinson, Scott E., and Robert Halvorsen. 1990. "The Valuation of Risks to Life: Evidence from the Market for Automobiles," Review of Economics and Statistics 72(1): 133-136.

Been, Vicki. 1993. "What's Fairness Got To Do With It? Environmental Justice and the Siting of Locally Undesirable Land Uses," Cornell Law Review 78 (September): 1001-85.

Been, Vicki. 1995. "Analyzing Evidence of Environmental Justice," Journal of Land Use and Environmental Law 11(1): 1-36.

Been, Vicki, and Francis Gupta. 1997. Coming To the Nuisance or Going To the Barrios? A Longitudinal Analysis of Environmental Justice Claims. Ecology Law Quarterly 24: 1.

Breyer, Stephen. 1993. Breaking the Vicious Circle: Toward Effective Risk Regulation (Cambridge: Harvard University Press).

Broome, John. 2000. "Cost-Benefit Analysis and Population," Journal of Legal Studies, in press.

Christensen, John. 1999. "New Questions Plague Nuclear Waste Storage Plan," New York Times, August 10, 1999, pp. D1 and D4.

Commission for Racial Justice. 1987. Toxic Wastes and Race in the United States: A National Report on the Racial and Socioeconomic Characteristics of Communities with Hazardous Waste Sites (New York: Commission for Racial Justice, United Church of Christ).

Dreyfus, Mark, and W. Kip Viscusi. 1995. "Rates of Time Preference and Consumer Valuations of Automobile Safety and Fuel Efficiency," Journal of Law and Economics 38(1): 79-105.

Gayer, Ted, James T. Hamilton, and W. Kip Viscusi. 1999. "Private Values of Risk Tradeoffs at Superfund Sites: Housing Market Evidence on Learning About Risk," Review of Economics and Statistics, forthcoming.

Hamilton, James T. 1993. "Politics and Social Costs: Estimating the Impact of Collective Action on Hazardous Waste Facilities," Rand Journal of Economics 24(1): 101-25.

Hamilton, James T. 1995. "Testing for Environmental Racism: Prejudice, Profits, Power?" Journal of Policy Analysis and Management 14(1): 107-32.

Hamilton, James T., and W. Kip Viscusi. 1999. Calculating Risks? The Spatial and Political Dimensions of Hazardous Waste Policy (Cambridge: MIT Press).

Hersch, Joni. 1998. "Compensating Differentials for Gender-Specific Job Injury Risks" American Economic Review 88(3): 598-627.

Hersch, Joni, and W. Kip Viscusi. 1990. "Cigarette Smoking, Seatbelt Use and Differences in Wage-Risk Tradeoffs," Journal of Human Resources 25(2): 202-27.

Hersch, Joni, and W. Kip Viscusi. 1998. "Smoking and Other Risky Behaviors," Journal of Drug Issues 28(3): 645-51.

Magat, Wesley, and W. Kip Viscusi. 1992. Informational Approaches to Regulation (Cambridge: MIT Press).

Moore, Michael J., and W. Kip Viscusi. 1988. "The Quantity-Adjusted Value of Life," Economic Inquiry 26(3): 369-88.

National Safety Council. 1998. Accident Facts, 1998 Edition. (Itasca, IL: National Safety Council).

Portney, Paul R. 1992. "Trouble in Happyville," Journal of Policy Analysis and Management 11(1): 131-32.

Thaler, Richard, and Sherwin Rosen. 1976. "The Value of Saving a Life: Evidence from the Labor Market," in Nestor E. Terleckyj, ed., Household Production and Consumption (Cambridge: National Bureau of Economic Research).

Viscusi, W. Kip. 1978. "Wealth Effects and Earnings Premiums for Job Hazards," Review of Economics and Statistics 60(3): 408-16.

Viscusi, W. Kip. 1979. Employment Hazards: An Investigation of Market Performance (Cambridge: Harvard University Press).

Viscusi, W. Kip. 1981. "Occupational Safety and Health Regulation: Its Impact and Policy Alternatives," in J. Crecine, ed., Research in Public Policy Analysis and Management, Volume 2 (Greenwich, CT: JAI Press).

Viscusi, W. Kip. 1992a. Fatal Tradeoffs: Public and Private Responsibilities for Risk (New York: Oxford University Press).

Viscusi, W. Kip. 1992b. Smoking: Making the Risky Decision (New York, Oxford University Press).

Viscusi, W. Kip. 1998. Rational Risk Policy (Oxford: Oxford University Press).

Viscusi, W. Kip. 1999. "The Value of Life in Legal Contexts: Survey and Critique," American Law and Economics Review, forthcoming.

Viscusi, W. Kip, and William Evans. 1990. "Utility Functions that Depend on Health Status: Estimates and Economic Implications," American Economic Review 80(2): 353-74.

Viscusi, W. Kip, Jahn K. Hakes, and Alan Carlin. 1997. "Measures of Mortality Risks," Journal of Risk and Uncertainty 14(3): 228-229.

Viscusi, W. Kip, and Joni Hersch. 1999. "Cigarette Smokers as Job Risk Takers," working paper, Harvard Law School.

Viscusi, W. Kip, and Wesley Magat. 1987. Learning About Risk: Consumer and Worker Responses to Hazard Information (Cambridge: Harvard University Press).

Zimmerman, Rae. 1994. "Issues of Clarification in Environmental Equity: How We Manage Is How We Measure," Fordham Urban Law Journal 21: 633-61.

Table 1
The Effect of Hazard Warnings for Asbestos on Worker Behavior

Variable	Mean Value
Initial risk assessment before seeing the asbestos warning (0-1 probability scale)	0.09
Risk assessment after receiving the asbestos warning (0-1 probability scale)	0.26
Workers refusing to stay on the job at any wage after receiving the warning (fraction)	0.11
Workers intending to quit if given no wage increase after receiving the warning (fraction)	0.65
Workers who would take the job again if given no wage increase after receiving the warning (fraction)	0.11
Additional wage premium for risk required (1995 $)	$4,734
Implicit value of an injury (value per statistical injury) (1995 $)	$27,846

Source: Viscusi (1998), p. 117.

Table 2
Regulatory Costs and Cost-Effectiveness in Saving Lives

Regulation	Year	Agency	Cost per life saved, millions of 1995 dollars	Cost per normalized life saved, 1995 dollars
Unvented space heater ban	1980	CPSC	0.1	0.1
Aircraft cabin fire protection standard	1985	FAA	0.1	0.1
Seatbelt/air bag	1984	NHTSA	0.1	0.1
Steering column protection standards	1967	NHTSA	0.1	0.1
Underground construction standards	1989	OSHA	0.1	0.1
Trihalomethane in drinking water	1979	EPA	0.2	0.6
Aircraft seat cushion flammability	1984	FAA	0.5	0.6
Alcohol and drug controls	1985	FRA	0.5	0.6
Auto fuel-system integrity	1975	NHTSA	0.5	0.5
Auto wheel rim servicing	1984	OSHA	0.5	0.6
Aircraft floor emergency lighting	1984	FAA	0.7	0.9
Concrete and masonry construction	1988	OSHA	0.7	0.9
Crane suspended personnel platform	1988	OSHA	0.8	1.0
Passive restraints for trucks and buses	1989	NHTSA	0.8	0.8
Auto side-impact standards	1990	NHTSA	1.0	1.0
Children's sleepwear flammability ban	1973	CPSC	1.0	1.2
Auto side door supports	1970	NHTSA	1.0	1.0
Low-altitude windshear equipment and training	1988	FAA	1.6	1.9
Metal mine electrical equipment standards	1970	MSHA	1.7	2.0
Trenching and excavation standards	1989	OSHA	1.8	2.2
Traffic alert and collision avoidance systems	1988	FAA	1.8	2.2
Hazard communication standard	1983	OSHA	1.9	4.8
Trucks, buses and MPV side-impact	1989	NHTSA	2.6	2.6
Grain dust explosion prevention standards	1987	OSHA	3.3	4.0
Rear lap/shoulder belts for autos	1989	NHTSA	3.8	3.8
Stds for radionuclides in uranium mines	1984	EPA	4.1	10.1
Benzene NESHAP (original: fugitive emissions)	1984	EPA	4.1	10.1
Ethylene dibromide in drinking water	1991	EPA	6.8	17.0
Benzene NESHAP (revised: coke by-products)	1988	EPA	7.3	18.1
Asbestos occupational exposure limit	1972	OSHA	9.9	24.7
Benzene occupational exposure limit	1987	OSHA	10.6	26.5
Electrical equipment in coal mines	1970	MSHA	11.1	13.3
Arsenic emission standards for glass plants	1986	EPA	16.1	40.2
Ethylene oxide occupational exposure limit	1984	OSHA	24.4	61.0
Arsenic/copper NESHAP	1986	EPA	27.4	68.4
Hazardous waste listing of petroleum refining sludge	1990	EPA	32.9	82.1
Cover/move uranium mill tailings (inactive)	1983	EPA	37.7	94.3

Table 2 cont.

Regulation	Year	Agency	Cost per life saved, millions of 1995 dollars	Cost per normalized life saved, 1995 dollars
Benzene NESHAP (revised: transfer operations)	1990	EPA	39.2	97.9
Cover/move uranium mill tailings (active sites)	1983	EPA	53.6	133.8
Acrylonitrile occupational exposure limit	1978	OSHA	61.3	153.2
Coke ovens occupational exposure limit	1976	OSHA	75.6	188.9
Lockout/tagout	1989	OSHA	84.4	102.4
Asbestos occupational exposure limit	1986	OSHA	88.1	220.1
Arsenic occupational exposure limit	1978	OSHA	127.3	317.9
Asbestos ban	1989	EPA	131.8	329.2
Diethylstilbestrol (DES) cattlefeed ban	1979	FDA	148.6	371.2
Benzene NESHAP (revised: waste operations)	1990	EPA	200.2	500.2
1, 2-Dechloropropane in drinking water	1991	EPA	777.4	1,942.1
Hazardous waste land disposal ban	1988	EPA	4,988.7	12,462.7
Municipal solid waste landfills	1988	EPA	22,746.8	56,826.1
Formaldehyde occupational exposure limit	1987	OSHA	102,622.8	256,372.7
Atrazine/alachlor in drinking water	1991	EPA	109,608.5	273,824.4
Hazardous waste listing for wood-preserving chemicals	1990	EPA	6,785,822.0	16,952,364.9

Source: Viscusi, Hakes, and Carlin (1997).

Table 3
Interaction Between Minority Population and Different Policy Analysis Alternatives

a. Sites with cleanup costs over $5 million

	Mean minority population (as % of site population) in all sites in simulation	Mean minority population (as % of site population) in all sites with cleanup costs over $5 million	Mean minority population (as % of site population) in all sites with cleanup costs over $5 million and cost per cancer case averted under $5 million	Mean minority population (as % of site population) in all sites with cleanup costs over $5 million and cost per cancer case averted under $100 million
Current Policy[a]	17	18	32	26
No ARARs[b]	17	17	39	25

b. Sites with cleanup costs under $5 million

	Mean minority population (as % of site population) in all sites in simulation	Mean minority population (as % of site population) in all sites with cleanup costs under $5 million	Mean minority population (as % of site population) in all sites with cleanup costs under $5 million and cost per cancer case averted under $5 million	Mean minority population (as % of site population) in all sites with cleanup costs under $5 million and cost per cancer case averted under $100 million
Current Policy[a]	17	14	17	12
No ARARs[b]	17	15	34	13

a. All sites in risk sample
b. Sites with cumulative risks of at least 10^{-4}. ARAR = Applicable or relevant and appropriate state or federal requirements

Source: Hamilton and Viscusi (1999), p. 234