Risk, Regulation and Responsibility: Principles for Australian Risk Policy

W. Kip Viscusi

with an introduction by Michael James

Introduction

by Michael James

On the very day in 1987 that the Hawke Labor government announced that Australia's two-airline policy would be terminated, the Labor Party's parliamentary Caucus voted in favour of prohibiting smoking on domestic flights. This coincidence neatly encapsulates modern trends in regulation. In recent years, the costs imposed on consumers by government restrictions on prices and on entry into markets have become more widely recognised. Despite the considerable political obstacles erected by the special interests that suffer loss of privilege as a result, some of these regulatory restrictions have been abolished, though many remain intact. By contrast, what are often called 'social' regulations---those governing relationships in both market and non-market activities---have continued to increase over the same period. Social regulation includes measures designed to protect the environment, to achieve equal opportunity for allegedly disadvantaged groups, and to promote health and safety.

Yet research (mostly conducted in the United States) has shown that, like economic regulation, much social regulation is flawed. It often fails to achieve its objectives; produces meagre benefits that cannot reasonably justify the cost; and gives rise to unanticipated and undesirable side effects. These weaknesses will have to become more widely recognised if the expansion of social regulation is ever to be contained.

The costs of social regulation include the immediate costs of creating, complying with, and enforcing them---time and resources whose value may exceed the benefits of the regulations. But there are powerful obstacles to evaluating social regulation from an economic perspective. Among them is public insistence that health and safety are 'too important' to be analysed in terms of their costs as well as their benefits.

A simple example, however, shows that society makes numerous trade-offs between money and lives in its approach to risk. Roughly 3,000 people die in road accidents each year in Australia. This number could be greatly reduced by more stringent vehicle speed limits, such as 20 kph on country roads and 10 kph in urban areas. But we don't take this course, because it would impose on us unacceptable sacrifices of other important goods and leisure pursuits. Moreover, such severe speed limits would increase risk in other directions. By restricting commerce and limiting economic growth, they would hold back the rise in living standards that enables us to afford progressively higher safety standards. Many regulations give rise to such unintended, and often unforeseen and counter-productive, consequences that rational policy-making should take into account. Yet there appears to be little recognition of this; and little effort is made to design regulations so as to avoid these problems.

One result of public misapprehension about risk is that regulators often concentrate on low-probability, esoteric risks while more important risks are neglected. They may also build excessive safety margins into the standards they prescribe. Professor Kip Viscusi illustrates the costs of such misallocation of resources with his calculation that US regulations for both the job exposures and the environmental exposures to asbestos in particular situations reduce risks at a cost in the vicinity of US$100m per case of cancer prevented. If this amount were spent on safer cars, for example, it would save far more lives. Subjecting regulation to cost-benefit analysis---aiming at what Professor Viscusi calls an 'efficient' level of risk---has the advantage of disciplining regulators so that they focus on the unintended consequences of regulation. Viscusi insists that cost-benefit analysis, even on the basis of incomplete information, is preferable both to doing nothing and to regulating on the basis of the worst-possible-case scenario.

One of the most valuable aspects of Professor Viscusi's paper is its demonstration of the ways in which health and safety standards are maintained spontaneously through voluntary processes. He argues that most improvements in the workplace injury rate in the US have been generated, not by occupational health and safety regulations, but by wage premiums for risky occupations and insurance premiums for workers' compensation. As outlined in the Appendix, in the US, these premiums are closely tied to workplace accident rates and therefore create an incentive for employers to improve workplace safety. Moreover, compensation insurance tends actually to reduce overall labour costs because it is so valued by workers that it more than offsets the cost of the wage premiums for risky jobs that employers would otherwise have to pay. Tort law is also effective in providing compensation, though not necessarily in creating incentives for the prevention of accidents.

From this standpoint, then, the role of government should be to identify where voluntary arrangements fail and then to use legislation to create legal incentives where market incentives are inadequate. A particularly important role for government is to provide public information about poorly understood hazards. But, where it does intervene, how can government know how much the public values improvements in safety that would guide it towards what Viscusi calls an 'efficient' level of risk? In other words, how much should government spend on health and safety measures? Viscusi argues that such decisions should be based on how much people choose voluntarily to spend on avoiding or reducing injuries and accidental deaths, or on amounts paid to induce workers to accept workplace hazards. Evidence from the US

and Australia suggests that people value a statistical (as opposed to an identified) life at around US$5m. This figure would confirm that the ban on asbestos cited above, which costs US$100m per death averted, is inefficient. But it would sanction the US regulation relating to underground construction, for example, which saves lives at a cost of only about US$300,000 each (in 1984 dollars). (Viscusi stresses the difference between statistical and identified lives because where the lives of known individuals are at stake we are prepared to pay much higher costs to save them.)

The economic approach to regulating risk offers perhaps the only systematic approach to establishing a cost-effective regime of health and safety regulation. Viscusi's demonstration that such regulation can reflect the public's estimate of the value of a statistical life gives the lie to claims that 'economic rationalists' ignore human values. But, for it to work well, this approach does demand a measure of intellectual responsibility on the part of the regulatory authorities, the public, and the media. It requires a recognition that risk is an aspect of all our activities that may be controllable but can never be wholly eliminated; that governments cannot know everything or do everything we would like them to; and that if they try to do so, the outcomes may be unsatisfactory. It also requires a healthy scepticism towards the fashionable and hysterical beat-ups of some risks at the expense of others by the many groups that compete to make us all anxious and depressed about something or other. Learning to live with risk and to cope with it is part of being grown up.

*Michael James is Editor of **Agenda**, the quarterly journal of the Centre for Applied Economics in the Faculty of Economics and Commerce at the Australian National University.*

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by W. Kip Viscusi

Introduction

In the US the unintentional death rate from accidents is 37.0 per 100,000 people in the population. In Australia, the comparable figure is 24.9 per 100,000 population.(1) Most of the difference between the two countries is attributable to the higher rate of automobile usage in the US, leading to a motor vehicle traffic death rate of 18.4 per 100,000 in the US as compared to 10.8 per 100,000 in Australia.(2) Some of the remainder of the difference is accounted for by the higher death rate of pedestrians and motorcyclists who are killed by motor-vehicle drivers in the US.

Even after adjusting for differences in activities, the Australian risk level compares reasonably well with that in the US. Moreover, as we survey the kinds of regulation in place in Australia, the usual regulatory efforts for work accidents, product safety, food safety, and tort liability are quite familiar. Performance on some dimensions comparable to that of the US should not, however, necessarily be a cause for complacency. The US record is in no way ideal, and the nature of the risk problems that are faced in the US may be sufficiently different in character. If, for example, the sole industry in the US was construction and the sole industry in Australia was banking and insurance, then there would be little cause for equalising the risk performance of the US. Because of differences such as these, international comparisons regarding the overall risk level are not the best way to think about approaching health and safety issues. As a result, the emphasis in this paper is on what a sensible risk level is and how the various social institutions' efforts should be targeted to promote this degree of safety.

Why should we tolerate any risk at all? In the US, labour leaders often claim that, so long as any worker is injured or killed on the job, regulations are not tight enough. Unfortunately, added safety costs money and there are limits to how much we can feasibly spend. If, for example, we were to devote the entire Australian gross domestic product to averting accidental deaths, we would be able to spend only A$77m per accident. That would leave no additional resources to spend on reducing injuries, occupational cancer, or to fulfil the other health-related consumption needs, such as the purchase of food, housing, and medical care. Clearly, we cannot make an unbounded commitment to saving lives. The question is: how much should we spend in this effort? The approach that I will take here is to look at the values that individuals themselves place on risks of death.

The Value of Life: Sources of Evidence

Consider the following experiment. Suppose that you are faced with a one in 10,000 risk of death. The risk is comparable to the annual occupational fatality risk for a typical American worker. Let us suppose this is a one-time-only risk that will not be repeated beyond the conference date. We will also assume that you can draw on future resources to buy out of this risk of death so that you are not constrained to your current finances. Finally, let the death be immediate and painless.

The key issue is: how much are you willing to pay to eliminate this risk? Almost invariably, respondents to this question indicate that they would not be willing to give up all of their present and future financial resources to buy out of this small

probability. Thus, we can rule out at the outset the possibility that statistical lives have an infinite value. The question is how large this finite amount is.

At the opposite extreme, individuals occasionally respond that buying out of such a small probability is worth nothing. However, such a response is also short-sighted as well, since it indicates an unwillingness to think carefully about small but highly consequential risks to life. If that same respondent were placed in a group of 10,000 individuals, perhaps at a sporting event, and told that one of them would be killed before the event was concluded, that prospect would surely not be a matter of indifference.

Suppose that the response is that reducing this one in 10,000 risk has a worth of $400. What does this answer imply about the magnitude of the tradeoff people are willing to make between lives and dollars? One approach to assessing the value per unit of risk is as follows: If a person is willing to pay $400 to eliminate a one in 10,000 risk of death, then the value per statistical life is simply the dollar amount divided by the probability involved: $4m. A second approach to understanding the nature of the calculation is more intuitive. Suppose that there are 10,000 people each of whom faces a one in 10,000 risk of death. If each of these people is willing to pay $400 to avert this risk, then the total amount of money that we could raise is $4m to eliminate the one statistical expected death among the group.

Because of the difficulty of thinking sensibly about such interview questions, the primary focus of economists has not been on survey valuations of risks, but rather on the tradeoffs that people actually make. The main focal point of these analyses has been labour market studies, though there have been analyses of the product market, purchase of smoke detectors, and other risky behaviours as well.

In the case of the labour market studies, analysts estimate earnings equations in which the determinants of worker earnings are analysed, including the role of demographic factors, job characteristics, personal characteristics, and other factors. Taking into account all these other influences, one then isolates the additional wage premium that is attributable to the mortality risks. The underlying theory beyond this analysis dates back to Adam Smith, who observed in 1776 that it is necessary to offer some additional type of compensation to attract workers to jobs that are hazardous or otherwise unpleasant. In the US the average job risk faced by a typical worker is one in 10,000, and workers in very high-risk jobs such as those in the construction industry face an annual risk of one in 1,000. Most studies of US workers indicate that on average the typical worker receives US$500 per year for an additional one in 10,000 risk of death, implying an implicit value of life on the order of $5m. Workers in high-risk jobs require a lower premium per unit risk to bear these risks and have an implicit value of life on the order of $1m or less.

Although most of these studies have been undertaken using US data, there has also been a similar analysis using industrial accident data for two digit manufacturing industries by State in Australia.(3) In this study, the average risk to workers was in the order of one in 10,000. Controlling for nonfatal injury risks, the authors found that the implicit value of life in 1990 US dollars was $3.3m. These estimates potentially can be refined by using data of individual workers as opposed to aggregate industry data.

However, the findings are quite striking in that they indicate a value of life for Australia that is not starkly different from those found in the US.

The underlying principle that is used in deriving these value of life numbers is that there are many accidents for which the consequences are reasonably well known. If individuals are aware of the risks, and if these risks are traded in a voluntary market exchange, as in the case of many job risks, then the individuals will require appropriate compensation in order to be willing to incur the risk. The magnitude of the wage premiums exhibited in such contractual situations can then be used to provide guidance for government regulations in situations in which the risks are not dealt with adequately by the market.

Use of the job market risks as the reference point does not imply that all job safety regulations are superfluous. Many risks, such as those posed by dimly understood carcinogens, will not be adequately reflected in market processes. Moreover, there may be profitable improvements that could be made in safety measures as well. However, it is noteworthy that the job risk valuation figures are in line with those found in other market contexts in which the value of life has been estimated as well as the values derived in survey studies.

The contexts in which economists have assessed the value of life are numerous. The choice of highway speed involves a tradeoff between the value of time and the risk of death. The decision to use auto seatbelts likewise has an associated implicit value of life on the order of US$1.2m.(4) The purchase of smoke detectors to alert one to fire risks in the home has been used to estimate the implicit value of life, as has the decision to stop smoking cigarettes.(5) In a recent paper with Mark Dreyfus I found that for used cars, the individual value of life reflected in these purchases range from US$3m--4m.(6)

Overall, statistical lives have a substantial value---in the order of several million dollars per statistical life. This amount exceeds the value of lost earnings by almost an order of magnitude. We are worth more than what we make, and the amount of funds that we have to purchase small reductions in risk is not subject to the kinds of stringent budget constraints that would be pertinent if we were buying out of truly substantial risks of death. Thus, large values that are attached to saving statistical lives are not implausible.

A similar kind of evidence is pertinent in the case of job injuries as well. Here, however, there is an intriguing pattern that has been identified in joint research with Joni Hersch.(7) Overall, workers value job injuries at US$48,000 per statistical injury. However, this valuation differs considerably depending on the type of worker. Individuals who smoke cigarettes and who have revealed themselves to be more willing to bear perceived risks have an implicit value of job injuries of US$26,000. Those who wear seatbelts require US$78,000 per statistical job injury. The group least willing to bear risk---nonsmokers who are also seatbelt users---value injuries at $83,000 per statistical injury. Thus, the attitudes toward risk differ across the population. One of the functions of the market is to match people with different preferences to market options in keeping with these preferences.

A final approach to eliciting valuations of risk that has become increasingly prominent is surveys. This approach is particularly useful in contexts in which the risk cannot be assessed meaningfully using market data, such as the value of natural resources. Economists have constructed surveys with respect to hypothetical situations to ascertain individuals' valuations of the commodity. These surveys are known as contingent valuation studies since the valuation is contingent on a hypothetical market existing for the product. In Australia, contingent valuation methods were used to estimate the valuation of the potential damage to Kakadu National Park resulting from gold mining at Coronation Hill.(8)

The specifics of the survey approach differ considerably. Respondents may, for example, confront an open-ended question asking them about the valuation of a particular resource. Alternatively, they might confront a series of paired comparisons. In the US, there was substantial controversy regarding the approach which was used to value the natural resource damages associated with the Exxon-Valdez oil spill.

A number of recurring issues arise with respect to such studies. First, are respondents used to thinking about the tradeoffs posed in the survey? If these tradeoffs are unfamiliar, as they are likely to be given the nonmarket nature of the commodity, then it may be difficult to develop a reasonable response. Second, does the survey relate to realistic decisions? If there is no credible mechanism for eliciting a willingness to pay from the respondent, then the legitimacy of these responses may be in question. Third, is the task subjects are presented with beyond their cognitive capabilities? Can people, for example, make refined distinctions with respect to various gradations of ecosystem damage and the ultimate consequences this damage may have for our environment? A long-term class of issues in the literature pertains to whether there will be strategic misrepresentation in the surveys as people overstate their responses in an effort to tilt the policy decision. Although survey techniques can be devised to avoid such biases, the more important practical problem is that respondents may simply not find the task of interest and may not be willing to give a thoughtful and meaningful response to a hypothetical question regarding a commodity that they know they will not buy in practice.

Value of Life Policy Guidelines

A key task for government policy is to value statistical lives. Thus, the risks involved entail small probabilities, not substantial risks to life and health. In addition, the lives at risk are unidentified lives. We do not know in advance whose lives will be saved through government programs. The decisions made are *ex ante*. In the case of regulatory efforts, company decisions to reduce risks, and individual decisions to avert risks, the decisions are made before the risk is incurred. Other compensation mechanisms, such as those through tort liability, operate after the fact, but these values for life may be quite different.

Overall, the task of the value-of-life numbers is to establish efficient incentives for preventing accidents. If firms invest less in reducing risks to life than is dictated by the value of life numbers, then the result will be that the level of safety will be insufficient. In that instance, the safety incentives of the marketplace will need to be bolstered through some form of intervention, including the provision of information, government regulation, or tort liability.

Perhaps the most important of these distinctions is that between identified and statistical lives. In the situation of a girl trapped in a well, a trapped coal miner, or even beached whales, we are dealing with identified lives. The society's attitude toward identified lives is often quite different, perhaps in part because of the substantial liability that these identified lives at risk generate. Our willingness to pay to avert losses to statistical lives is typically much less, which was indicated above to be in the order of $5m.

An interesting policy question is: which preference represents the true value? If we knew that the random person saved would be Geoff Hogbin, would this knowledge alter our value? Suppose they would let us attach a higher value to his life. If we would attach such a higher value to the identified life being saved irrespective of who it was that was identified *ex post*, it may be that we should rethink the appropriate value that we are attaching to lives.

The magnitude of the risk often is a matter of concern as well. The position I will take here is that we should let the expected number of lives saved be our guide. However, if we were to save 100 people out of a group of 1,000, such an effort would typically receive more attention than saving 100 people out a population of 1,000,000. It is in part because of the risk level and the value we attach to concentrations of risk that catastrophes often receive targeted emphasis through government programs.

How we feel about the magnitude of the risk will influence the risk reduction strategies we will undertake. Is it better to rotate nuclear power plant workers or to let a few workers be exposed to substantial risk levels? If there is a linear dose-response relationship and no threshold for the risk, the expected number of lives adversely affected will be the same. Similarly, should we rotate aeroplane flight crews because of the exposure to radiation? Often society appears to reflect a concern that the magnitude of the risk is unreasonable rather than worrying about whether the risk level itself is efficient.

The key feature of statistical lives is that they are quite different. One's life at age 50 is much shorter than one's life at age 20. Air pollution tends to affect disproportionately the very old and the very young. How should these lives be valued relative to mid-career blue-collar workers who tend to be exposed to hazardous jobs? More work needs to be done in refining the value of life estimates for populations such as these.

Wealth and Health

The rich live longer than the poor. Disabilities in Australia are 40 per cent higher among machine operators and labourers than among professionals.(9) The death rates of the men in the lowest 10 per cent of the Australian occupations are almost two-and-a-quarter times greater than those for the men in the highest 10 percent. A wide variety of other ailments, ranging from arthritis to chronic bronchitis, have a higher incidence among the lower-income families in Australia.

Wealth and health are inextricably linked. Evidence pertaining to the value of life suggests that this value increases roughly proportionally with income. What these results indicate is that the higher the amount of one's income, the more averse one will

be to incurring risks. The rich will be willing to pay a higher price for safe products and will demand more extra compensation to incur risks on a hazardous job. Because of this greater premium, it is more costly for employers to offer risky job conditions to the more affluent. Thus the incentives to provide safety will be greater when the upper-income workers are exposed. It is not entirely coincidental that the most expensive safety improvements for automobiles, such as the introduction of airbags and antilock brakes, occurred first for the higher priced luxury car models.

The wealth-health relationship also largely accounts for the steady improvement in risk levels over time. By almost any measure, we are dramatically better off in terms of the risk levels we face today. From 1912 to 1993, unintentional injury deaths in the US per 100,000 population dropped by 57 per cent.(10) This decrease occurred in spite of the fact that motor vehicle accidents were virtually nonexistent in the early part of the century and now account for the majority of all accidental deaths. Moreover, this decline in accidents has occurred steadily throughout the century, long before the US began its substantial initiative to regulate risks.

The overall message of these statistics is two-fold. First, an extremely powerful force driving safety will be the marketplace. As we become more affluent, we will demand higher levels of safety, thus fostering the safety incentives for the risks that are traded in the market. These forces that have worked through the market have been extremely powerful. If we are to turn to other social institutions to promote safety, such as government regulations, we should attempt to emulate the manner in which the market produces these powerful safety incentives.

The second implication is that within the context of valuing life, this heterogeneity suggests that the rich value their lives more than do the poor. At the current state of policy refinement, these differences will seldom play an important role. Moreover, there is the ethical question of what role such differences in valuation should play. In the case of airline safety, for example, the passengers exposed to risk are typically wealthier. Should we regulate airline safety more stringently than job safety? One might wish to be averse to such distinctions since doing so shows a preference toward the more affluent. However, since the cost of safety in effect will be paid for largely through higher ticket prices, then one should realise that what is happening is not a subsidy for the rich but rather a reflection of their preferences in the standards set by the government. Thus, in situations in which the safety improvements will in effect be financed by the beneficiaries, it seems unobjectionable to reflect the preferences of these beneficiaries in the risk valuation.

This class of issues is similar to that with respect to the Titanic. For that vessel, the designers provided lifeboats for those travelling in First Class, making no provision for the other passengers. Given the cost of providing the lifeboats, conceivably such a decision could have been based on a rational calculation, though it is doubtful that any such calculation was ever made. However, even if such decisions could be justified, they should certainly be intolerable. In the event of a major catastrophe, individuals are not facing small statistical risks to their lives. Rather, they are dealing with the *ex post* certainty of death. In this situation, making distinctions across income groups is both intolerable and infeasible.

Income-level differences also play an important role with respect to international risk levels. Should we, for example, equalise the risk levels in all countries? Some individuals, particularly those representing protectionist-oriented US labour unions, have suggested that the US should not import goods that are produced in a hazardous manner or produced by a polluting country. However, import bans such as this ignore the differences in the stage of development across countries. If we do not import goods from less developed countries because they do not live up to more advanced safety standards, then the result will be a decrease in their income and an overall adverse effect on their health. Would it, for example, have been reasonable to impose the safety standards of today on Australia 40 years ago? Measures such as this ignore the difference in the stage of development of different countries.

Similar types of concerns have arisen with respect to the standards for risky exports. Should industries in the home country be permitted to export products that do not meet the home country's safety standards but do meet the standards in the importing country? US pharmaceutical firms, for example, cannot produce in the US prescription drugs for export even if the drugs have been approved in Australia, Europe, and elsewhere unless they have also been approved for sale in the US. Due to the lag in the drug review process, it is often difficult to meet this constraint.

The income-risk relationship has also led to the development of a new policy perspective on the relationship between income and risk.(11) Regulatory expenditures decrease the resources available for other uses. Increases in regulation lead to higher prices, lower wages, and higher taxes. These regulatory costs represent real opportunity costs of resources that could have been allocated elsewhere.

This decrease in available resources due to regulatory expenditures generates decreased spending on improvements in health status. There is a reduction in both direct mortality-reducing expenditures as well as expenditures for higher-quality consumer items, such as safer cars.

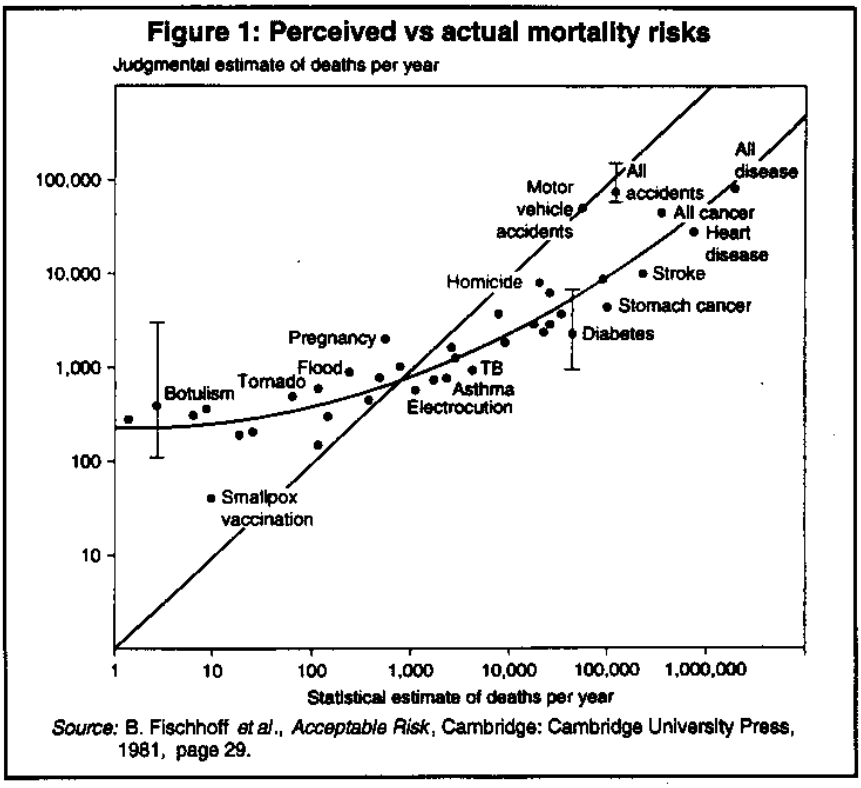
Three different approaches have been used to assess the income loss that is necessary to lead to the loss of a statistical life because of regulatory costs. The first technique, which is based on direct estimates of the relationship between income and mortality, often differs widely. Most of them seem to cluster in range of US$12m or less. The second set of estimates, which is based on evidence pertaining to the value of life and expenditures on health care, indicates that a life is lost every time we lose an amount of income equal to US$50m. Finally, evidence based on risky personal consumption habits, such as lack of exercise, suggests that for every income loss of $18 to $20m there is a loss of a statistical life.

Although the exact value of the income loss associated with the loss of a statistical life has not been pinpointed, a wide variety of studies using several different methodologies indicate that somewhere between a $10m income loss and a $50m loss there is the loss of a statistical life from the wealth--risk relationship. Similarly, an increase of this magnitude will lead to the saving of a statistical life. Increases in society's affluence will consequently lead to additional improvements in longevity. However, the discouraging variant of this result is that if we squander our resources on regulatory expenditures that are not effective in saving lives, then we run the risk

of losing more lives than will be saved through our profligacy. I will return to this effect below in my discussion of regulatory policies.

Information Provision

Individuals may not always have accurate information with respect to the risks they face. If this is the only deficiency that prevents individual contracts from being effective in creating appropriate safety incentives, then it could potentially be remedied through information provision. This information could be provided voluntarily through the market, though typically regulatory policies or tort liability sanctions are imposed to bolster these incentives.



Source: B. Fischhoff *et al*., *Acceptable Risk*, Cambridge: Cambridge University Press, 1981, page 29.

Figure 1 indicates the level of individual assessments in mortality risks relative to the actual risks posed by a variety of causes of death. Risk perceptions are not always accurate. However, the biases in these risk perceptions are often systematic. We tend to overestimate the very dramatic highly publicised risks associated with natural disasters, such as tornadoes, floods, and earthquakes. The more common risks that pose the most substantial danger to our lives---the risks of heart disease, cancer, and stroke---tend to be underestimated. The result is that we often overreact to the minuscule risks we face and place inadequate emphasis on the more fundamental hazards to our well-being. The risks associated with lifestyle are often among these most fundamental hazards, such as those from drunken driving, poor diets, and lack of

exercise. These risks receive far too little attention when compared to the microscopic contingencies, such as the threat posed by a newly identified carcinogen.

The way in which risk affects decisions is often inconsistent with what one would view as entirely rational behaviour. Consider the situation in which respondents are able to purchase reductions in the risks posed by insecticide, where the starting risk level is 15 injuries per 10,000 bottles and the risks involved are the risks from inhalation and skin poisoning. To reduce the risks from 15 in 10,000 to 10 in 10,000, respondents are willing to pay $1.04. Economic theory predicts that there should be a diminishing willingness to pay for successive reductions in risk. That is what we observe, as people are willing to pay $0.34 for a risk reduction from 10 in 10,000 to 5 in 10,000. There should also be an additional decrease in the willingness to pay associated with decreasing the risk to zero. However, this last increment risk reduction from five in 10,000 to zero has an associated willingness to pay of $2.41 per bottle of insecticide. Thus, respondents are much more willing to pay for the risk reduction that leads to complete elimination of the risk than for risk changes of comparable magnitude that do not provide complete assurance that the risk has been eliminated. This result stems both from the overestimation of small probabilities and consequently the excessive valuation placed on the certainty of no risk as well as the potential influence of being able to eliminate anxiety once the zero-risk level has been reached.

Now suppose we are to consider instead the valuations people attach to possible increases in the risk associated with the reformulation of the product. If the risks were to be increased from 15 in 10,000 to 16 in 10,000---a much more modest risk change than the risk decreases considered earlier---77 per cent of the respondents would be unwilling to purchase the product at any price. For those respondents who would still be willing to buy the product, they would require an average $2.86 discount per bottle: almost three times as much as their willingness to pay for a risk decrease that was five times as great. The rates of risk tradeoff are highly inconsistent, as there is substantial aversion to departing from the reference risk level to which one has become accustomed. These anomalies in risk perceptions in choice under uncertainty are not unique. Researchers have documented a wide variety of systematic departures from rational behaviour. People overestimate small identified risks, whereas they often ignore small unidentified risks. People also tend to underestimate the large risks that have greatest consequence. Publicity has a distorting rather than an informative role as people tend to overestimate highly publicised risks as well as those risks with which they have had recent experience. More generally, people display a limited cognitive ability to process information regarding very small probabilities. For example, 0.00002 and 0.00001 appear to be quite similar to respondents rather than differing by a factor of 2, whereas 0.2 appears to be much greater than 0.1.(12)

A well structured format for the risk information often improves understanding. However, risk information does not always lead to accurate risk beliefs. Table 1 summarises data on smoking risk beliefs.

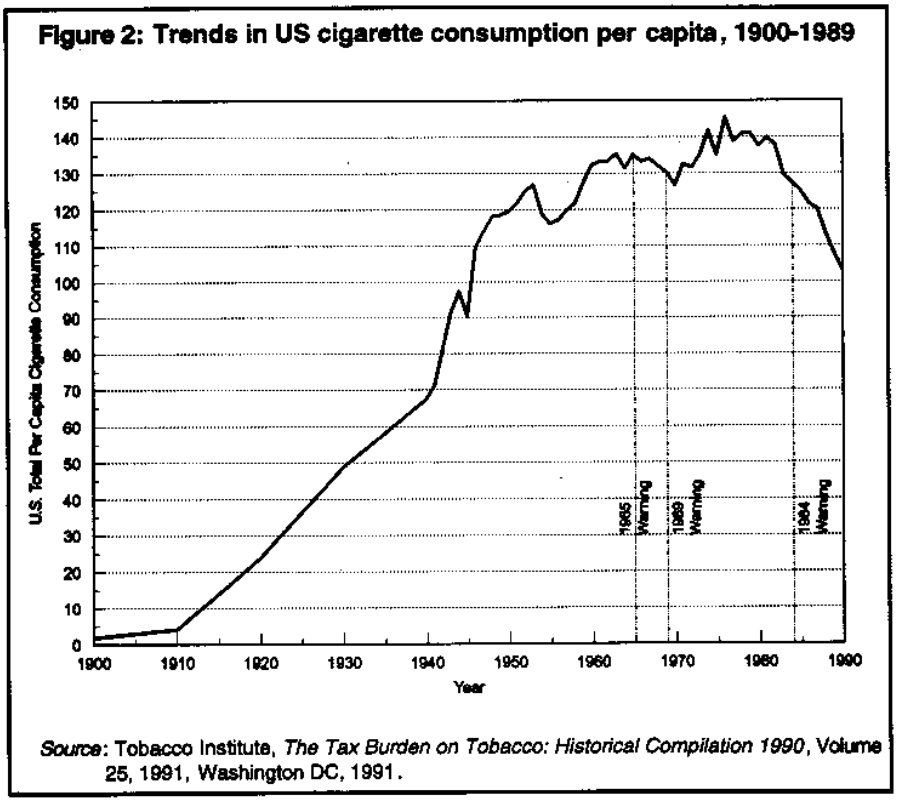
Table 1: Summary of smokersÕ risk perceptions

Risk perception	Full sample	Smokers
Lung cancer risk (1985)	0.43	0.37
Lung cancer fatality risk (1991)	0.38	0.31
Total smoking mortality risk (1991)	0.54	0.47

Source: W. K. Viscusi, *Smoking: Making the Risky Decision*, New York: Oxford University Press, 1992, pages 69 & 77.

For a national sample, on average people estimated that the lung cancer risk associated with smoking is 0.43---far above the risk now estimated by scientists, which is in the range of 0.06-0.13. Even the total mortality risk of smoking is greatly overestimated, as people assess the risk at 0.54, which contrasts to scientific estimates in the range of 0.18--0.36. Similarly, respondents greatly overestimate the life expectancy loss associated with smoking, estimating it to be 13.0 years of life expectancy loss, which is more than double any reasonable estimate.

Although there has been a long-term awareness of smoking risks, hazard warnings have played a role as well. Figure 2 illustrates the trend in US per capita cigarette consumption over time. The advent of hazard warnings is associated with a flattening of the growth in consumption in the 1960s and the downturn in smoking in the 1980s. A more refined statistical analysis suggests that the main effect of the warnings has been greatly to increase the purchase of low-tar cigarettes. Thus, warnings are consequential, and my research has also shown that smoking behaviour is responsive to risk beliefs. However, individuals in this context greatly over-assess the risks that are present. Increasing risk perceptions is not necessarily desirable. The objective of policy should be to foster accurate risk perceptions so that people can make sound decisions. There are limits to the extent to which information should be alarmist in character. Excessively alarmist warnings also may damage our credibility in other informational contexts.



Source: Tobacco Institute, *The Tax Burden on Tobacco: Historical Compilation 1990*, Volume 25, 1991, Washington DC, 1991.

Principles for Hazard Warnings

Based on a large number of studies of consumer and worker warnings, I have derived five overall principles for hazard warnings. First, an effective warning should provide new information in a convincing manner. Warnings that serve as reminders and that simply reiterate what is already known tend to be relatively ineffective.

Second, in the design of warnings we should recognise that individuals have cognitive limitations. Not all warnings will be received and processed by the individual. As a result, we need to pay particular attention to the structure and format of the information being provided.

Third, the focus should not be on hazard warnings or labels as such but rather on the overall hazard communication system. What are all the different risks posed by the product or activity and what are the various ways in which we can communicate those risks? An on-product label is just one mechanism. Videos, television advertisements, physician-provided information, a public education effort, and similar mechanisms should also be considered among the potential policy mix.

Fourth, standardisation is desirable. In many regulatory contexts, economists usually urge diversity and flexibility. However, in the situation of hazard warnings, it is beneficial to establish the uniform warnings vocabulary that will assist individuals in processing the warning information. The model warnings approach in this regard is that for prescription drugs in the US, in which the placement of the information regarding uses, adverse reactions, dosage, and other aspects of the product is structured in a systematic way that is common across products.

Fifth, over-warning is dangerous. Being unduly alarmist is not desirable. Not only do such warnings sacrifice one's credibility in that particular warnings context, but they also distort relative product comparisons. If everything is labelled hazardous, we will be unable to make distinctions regarding the situations that truly do merit care.

Risk Assessment

Consider two policy options. Policy option A saves 500 lives with certainty, and policy option B offers a 50/50 chance of saving either 200 lives or 600. Which policy should we pick if we only have the budget available to pursue one of them?

Policy option A saves the greater expected number of lives. Policy option B offers the greater potential gains and will be chosen if we focus on the worst-case scenario. Current risk-assessment practices in the US tend to focus on the upper bound of the risk rather than the mean risk level. This approach is currently being challenged by a variety of pieces of legislation that were passed in 1995. The danger from the conservative approach of focusing on the worst-case scenario is that we distort priorities by focusing on the inconsequential risks that are least precisely understood. The real risks that offer the greatest expected gains are often neglected.

The nature of the biases in risk-assessment practices is quite diverse. In analysing air pollution and emissions, sometimes it is assumed that all plants operate at full capacity. In other instances analysts ignore the important role of adaptive responses by individuals who can often avert the risk. Focusing on the upper end of the 95 percent confidence interval is one manifestation of the statistical biases, but these are often compounded by multiplying the estimated risk level by an arbitrary factor, such as 10, for the sake of conservatism. Focusing on the most sensitive animal species and using a one hit linear model often lead to a conservative bias as well.

The danger of these different biases is that there is confusion between risk assessment and risk management. If society wishes to be conservative in its risk management practices, it should do so through utilisation of a high implicit value of life, not by distorting the underlying scientific basis for action.

The diverse nature of the biases in risk perception can be illustrated with reference to the US Superfund program, which is the hazardous waste clean-up effort for toxic chemicals. One major bias in the approach is that there is no distinction made between populations currently at risk and potential future populations that might be exposed, even if such exposures are highly unlikely and there are not people currently residing in the area who could potentially be exposed. Overall, 90 per cent of all the risk pathways, which are the mechanisms by which people can be exposed to the risk,

pertain to such hypothetical future pathways. Yet, these future pathways are treated with the same weight as are actual risk exposures.

Similar kinds of biases permeate the analysis. In discussing the role of conservatism, one might think that such conservative biases are confined to some single risk number. However, most risk calculations are based on a combination of assumptions, and the incorporation of conservatism in each component of the analysis leads to a compounding of the biases. In the case of the estimation of risk for groundwater ingestion associated with hazardous waste sites, the US Environmental Protection Agency uses the upper bound values for the ingestion rate, the exposure frequency, the exposure duration, the chemical concentration, and the toxicity of the chemical. The result is that the estimated risk value lies well beyond the 99th percentile of the possible risk distribution. Thus, we are assessing the risk as being much greater than it actually is or might even conceivably be under worse case scenarios that have some reasonable probability.

The importance of assessing the magnitude of the risk in structuring our efforts to reduce hazards is apparent from inspection of the data in Table 2 . The existence of a risk alone is not cause for a government action or avoidance of the risk by the individual. Table 2 summarises a variety of causes of death that account for one in a million risk of death. These risks include smoking 1.4 cigarettes, drinking 0.5 litres of wine, travelling six minutes by canoe, eating 40 tablespoons of peanut butter, and eating 100 charcoal broiled steaks. Although society has selected some particular risks for regulation, the existence of the risk in itself is not the rationale for the regulation. Nor is it feasible to reduce all risks we face to zero.

Table 2: Risks that increase the annual death rate by one in 1,000,000

Activity	Cause of Death
Smoking 1.4 cigarettes	Cancer, heart disease
Drinking 0.5 litres of wine	Cirrhosis of the liver
Spending 1 hour in a coal mine	Black lung disease
Spending 3 hours in a coal mine	Accident
Living 2 days in New York or Boston	Air pollution
Travelling 6 minutes by canoe	Accident
Travelling 10 miles by bicycle	Accident
Travelling 150 miles by car	Accident
Flying 1000 miles by jet	Accident
Flying 6000 miles by jet	Cancer caused by cosmic radiation
Living 2 months in average brick or stone building	Cancer caused by natural radioactivity
One chest X-ray taken in a good hospital	Cancer caused by radiation

Living 2 months with a cigarette smoker	Cancer, heart disease
Eating 40 tablespoons of peanut butter	Cancer caused by aflatoxin B
Drinking Miami drinking water for 1 year	Cancer caused by chloroform
Drinking 30 12-oz cans of diet soft drink	Cancer caused by saccharin
Drinking 1000 24-oz soft drinks from banned plastic bottle	Cancer from acrylonitrile monomer
Eating 100 steaks barbecued on charcoal	Cancer from benzopyrene
Living 150 years within 20 miles of a nuclear power plant	Cancer caused by radiation
Source: Extracted from W. Kip Viscusi, ÔRisk, Regulation and Responsibility: Principles for Australian Risk PolicyÕ. Original source: Richard Wilson, ÔAnalysing the Daily Risks of LifeÕ, *Technology Review* 81(**4**), 1979, pages 40-46.	

Carcinogens likewise are not unique to the potent chemicals that are often the target of regulatory policy. The ethyl alcohol in beer is carcinogenic, as is the caffeic acid that occurs naturally in apples, pears, coffee, plums, celery, carrots, potatoes, and a large number of other food products. Unfortunately, in the US it is the synthetic character of the risk rather than the magnitude of the risk that tends to drive regulatory action.(13) Risk tradeoffs are made throughout the course of our lives. Elephant handlers in the Philadelphia Zoo receive $1,000 extra pay per year because elephants are said to pose risks for handlers they do not like. Similarly, the fire fighters in Kuwait received $500,000 per year, much of which no doubt reflected a premium for their substantial risks.

Before considering whether the tradeoff to be made with respect to risk regulation is appropriate, the first question that should be asked is why there should be regulation at all. In particular, what is the market failure? In the absence of some inadequacy in the way in which private contracts have been made, there is no rationale for intervening in these private agreements and individual choices to bear risk. The potential sources of market failure include the presence of externalities (such as air pollution), underestimation of the risk, irrational behaviour, altruistic concerns, and neglected impacts on future generations. Some of these factors, such as underestimation of the risk, can be addressed through informational efforts. In addition, tax policies that discourage activities may be useful in discouraging other types of behaviour, particularly if the tax can be explicitly linked to the risk level.

Table 3 summarises the performance of US government risk regulations based on the value of the cost per life saved. Suppose that we were to take $5m per life saved as the threshold for reasonable risk regulation policies. The regulations at the top part of Table 3 pass this benefit-cost test. Many of the most beneficial regulations are transportation related, as the enabling legislation for these activities does not prohibit

the consideration of benefits and costs in setting regulatory policy. In contrast, environmental and occupational safety regulations often are highly ineffective in reducing risk, some with the cost per life saved in excess of $100m.

Table 3: Risks and cost-effectiveness of selected US regulations

Regulation	Year and Status	Agency	Initial annual risk (a)	Annual lives saved	Cost per Life Saved (Millions of 1984 $)
Pass benefit-cost test:					
Unvented space heaters	1980 F(b)	CPSC	2.7 in 10(5)	63	0.1
Oil and gas well service	1983 P	OSHA-S	1.1 in 10(3)	50	0.1
Cabin fire protection	1985 F	FAA	6.5 in 10(8)	15	0.2
Passive restraints/belts	1984 F	NHTSA	9.1 in 10(5)	1850	0.3
Underground construction	1989 F	OSHA-S	1.6 in 10(3)	8.1	0.3
Alcohol and drug control	1985 F	FRA	1.8 in 10(6)	4.2	0.5
Servicing wheel rims	1984 F	OSHA-S	1.4 in 10(5)	2.3	0.5
Seat cushion flammability	1984 F	FAA	1.6 in 10(7)	37	0.6
Floor emergency lighting	1984 F	FAA	2.2 in 10(8)	5	0.7
Crane suspended personnel platform	1988 F	OSHA-S	1.8 in 10(3)	5	1.2
Concrete and masonry construction	1988 F	OSHA-S	1.4 in 10(5)	6.5	1.4
Hazard communication	1983 F	OSHA-S	4.0 in 10(5)	200	1.8
Benzene/fugitive emissions	1984 F	EPA	2.1 in 10(5)	0.31	2.8
Fail benefit-cost test:					

Grain dust	1987 F	OSHA-S	2.1 in 10(4)	4	5.3
Radionuclides/uranium mines	1984 F	EPA	1.4 in 10(4)	1.1	6.9
Benzene	1987 F	OSHA-H	8.8 in 10(4)	3.8	17.1
Arsenic/glass plant	1986 F	EPA	8.0 in 10(4)	0.11	19.2
Ethylene oxide	1984 F	OSHA-H	4.4 in 10(5)	2.8	25.6
Arsenic/copper smelter	1986 F	EPA	9.0 in 10(4)	0.06	26.5
Uranium mill tailings, inactive	1983 F	EPA	4.3 in 10(4)	2.1	27.6
Uranium mill tailings, active	1983 F	EPA	4.3 in 10(4)	2.1	53
Asbestos	1986 F	OSHA-H	6.7 in 10(5)	74.7	89.3
Asbestos	1989 F	EPA	2.9 in 10(5)	10	104.2
Arsenic/glass manufacturing	1986 R	EPA	3.8 in 10(5)	0.25	142
Benzene/storage	1984 R	EPA	6.0 in 10(7)	0.043	202
Radionuclides/DOE facilities	1984 R	EPA	4.3 in 10(6)	0.001	210
Radionuclides/elem. phosphorous	1984 R	EPA	1.4 in 10(5)	0.046	270
Benzene/ethylbenzenol styrene	1984 R	EPA	2.0 in 10(6)	0.006	483
Arsenic/low-arsenic copper	1986 R	EPA	2.6 in 10(4)	0.09	764
Benzene/maleic anhydride	1984 R	EPA	1.1 in 10(6)	0.029	820
Land disposal	1988 F	EPA	2.3 in 10(8)	2.52	3500
EDB	1989 R	OSHA-H	2.5 in 10(4)	0.002	15600
Formaldehyde	1987 F	OSHA-H	6.8 in 10(7)	0.01	72000

Notes:
(a) Annual deaths per exposed population. An exposed population of 10(3) is 10 to the power of 3, that is, 1,000; 10(4) is 10,000, etc.

(b) F, P, or R = Final, proposed, or rejected rule.

Source: J. F. Morrall III, ÔA Review of the RecordÕ, *Regulation*, Volume 10, Number 2, 1986, page 30, updated by John Morrall via unpublished communication with the author, 10 July 1990.

Extravagant regulatory expenditures are more than wasteful. Squandering social resources in an effort to reduce risks imposes substantial opportunity costs that in effect make society poorer. Because of the income-mortality relationship discussed above, these efforts may be counterproductive in that the resources diverted to pay for the regulatory expenditures could have had a more beneficial effect on health than the direct effects of the regulation.

Finally, notwithstanding the often substantial cost per life saved associated with regulations, there are few dramatic regulatory success stories. The effect of job safety regulations has, for example, been relatively modest, with at most a 2--4 per cent effect on serious job injuries. Perhaps the most dramatic regulatory success story has been with respect to improved environmental quality. The phase-down of using lead in gasoline resulted in dramatic reductions in lead pollution levels. What is especially noteworthy about this improvement is that this regulation also passed a benefit-cost test.

A key issue with respect to regulation is the appropriate governmental level for the regulation. In the US, most regulation is at the Federal level, though States have some responsibility in the regulatory areas as well. In Australia, there is more reliance on the States. Selection of the appropriate governmental level for regulation relates to the debate over federalism.

The rationale for State regulation stems from a variety of different influences. If preferences vary across different States, then differences in regulation can reflect different attitudes toward risk.

Heterogeneous regulations also can take into account differences in regulatory compliance costs in different States. Regulation in different States also promotes diversity and experimentation. Uniform national standards offer the advantage of economies of scale for a firm attempting to comply with regulations in a number of different locales. Producers of mass-marketed consumer products, for example, generally prefer uniform national standards since these entail lower costs associated with market and distribution. There is, however, no general conclusion regarding the appropriate governmental level for regulation since the merits of decentralised regulation vary depending upon the regulatory context. For highly complex scientific regulations for which a substantial scientific research effort is needed, regulation at the national level is typically more appropriate. What is clear is that these issues should be dictated by the merits of regulations at different levels of the government rather than based on historical inertia.

Social Insurance and Tort Liability

Although regulation serves as one mechanism for augmenting market forces, it is not unique in providing economic incentives. *Ex post* compensation through both tort liability awards and workers' compensation also serves to create financial incentives for safety.

In the case of workers' compensation in the US, the safety effect arises because of the linkage of workers' compensation premiums to the firm's accident performance. Particularly for large firms for which such merit rating is very feasible, workers' compensation establishes strong safety effects. Thus, the $30 billion annual premium cost of workers' compensation should not be viewed as simply a transfer mechanism to assist workers, but should be more properly regarded as a funding mechanism which also establishes powerful incentives for safety improvements. In the case of Australia, the workers' compensation premium total is $5 billion, but there is also recognition of the importance of using the incentives that could potentially be provided by workers' compensation.(14) In the US, worker fatality rates would be almost one-third higher in the absence of the financial incentives created by workers' compensation.(15) Thus, the main lesson from the workers' compensation experience in the US is that incentives matter.

It also should be noted that workers' compensation programs and similar mechanisms for providing compensation to accident victims are valued by those who receive them. In the absence of compensation for job injuries, workers would be much more averse to incurring risks on jobs than they now are. Indeed, this aversion is so great that in the US wage costs would rise by more than the value of workers' compensation premiums if the workers' compensation system were abolished. The provision of workers' compensation benefits is a valued attribute of the job that reduces the wage that individuals require to accept work at those positions.

A similar argument is also made with respect to tort liability. For example, in the case of product liability, consumers may in effect pay for the costs of liability through higher product prices at the time of product purchase. Thus, in effect they are buying an insurance policy that is bundled with a commodity.

Several caveats should be noted in this regard, however. First, this analogy is most appropriate for outcomes such as random manufacturing defects that occur on an isolated basis. In the US, over the past two decades there have emerged mass toxic torts involving asbestos, Agent Orange, DES, Bendectin, breast implants, and some pharmaceutical products. In situations in which there are thousands of claimants, all of whom suffered injuries in the past that were not anticipated at the time of the product sale, the product price will not have already reflected the potential insurance costs. Nor will it be possible to shift these costs to future consumers of the product since they are only willing to bear costs associated with their purchases, not those of earlier waves of consumers.

The second difficulty with the tort-liability insurance analogy is that the risks are highly correlated. Insurance works most effectively where there is a portfolio of random risks. In these instances, insurers pool these various random risks and write policies based on the average performance; but if the possible outcomes are no claims or a catastrophic group of claims, then such risk pooling will not be effective.

Apart from such limitations, tort liability can serve a constructive role. Both strict liability and negligence rules can potentially lead to efficient levels of accident avoidance, depending on the particular assumptions one makes regarding the behaviour over which the economic actors have control. Tort liability also leads to a transfer of resources to the accident victim to meet the income and medical needs as well as compensating for pain and losses. However, the magnitude of this compensation is not equivalent to the value of life figures that are pertinent for regulatory policy or individual risk-averting decisions. Individuals would not choose knowingly to purchase a life insurance policy that provided for a $5m payment upon their demise. That amount of insurance would be excessive since income has a lower marginal utility after one's death. That does not imply that the $5m implicit value of life reflected in attitudes towards small risks was irrational. Rather, these expenditures to avert one's death have a quite different purpose from transfers of money after one's death. The basic difficulty is that a $5m court award for a person who is fatally injured is sensible from the standpoint of creating appropriate deterrence, but such award values are excessive from the standpoint of providing optimal insurance to the accident victims.

Thus we are left with a situation in which court awards can provide some incentives for safety, but can never be relied upon to meet totally the same level of safety incentives as would be achieved through a well functioning contractual arrangement or regulatory system. Nevertheless, the court system often does play a useful role. Victims of routine accidents, such as automobile accidents, benefit from the insurance value of court awards. Moreover, even some of the mass toxic torts, such as the asbestos cases, have played a useful role. Although the imposition of liability on firms that was in large part retroactive would not be effective in creating efficient incentives for safety at the time of their imposition, the wave of asbestos cases did serve to focus public attention on the hazards of asbestos, leading to additional government regulation. The difficulty is that this regulation was both long overdue and, once adopted, overzealous. The regulations for both the job exposures and the environmental exposures to asbestos reduce risks at a cost in the vicinity of $100m per case of cancer prevented. Excessive regulation is not appropriate even if it follows a tragic period of substantial regulatory inaction. The major policy objectives should be to avoid catastrophes such as the massive exposures to asbestos which occurred after and during World War II, rather than to issue regulations that are more punitive in nature, and are disproportionate to the magnitudes of the risk involved.

There are also common elements to the reform movements that have been underway throughout the world. For example, joint and several liability reform has been a major item on the reform agenda in the US as well as in Australia. The underlying tension is that a liability proportional to one's responsibility for the accident is more consistent with providing appropriate incentives for accident avoidance, whereas making the remaining solvent party to an accident responsible for the damages better promotes the compensation objective of tort cases. The practical difficulty is that there may be substantial inequities from holding the 'deep pocket' liable for the cost of an accident for which it is not largely responsible. Various compromises are possible, such as having joint and several liability only for economic damages, not for nonmonetary damages. Unfortunately, virtually all of these liability reform proposals are highly imperfect because no ideal tort liability system exists.

Conclusion

A key problem that must be confronted in the design of regulatory policies is the appropriate institutional division of labour. The existence of a risk does not imply that there are no market forces in operation. The role of the market and individual desires for safety have largely accounted for the dramatic improvements in safety throughout this century. The financial incentives created by the market continue to dwarf those provided by government regulation. It is only by understanding the importance of these market incentives and attempting to recognise where these incentives will not be fully effective that we will be able to achieve the most that is possible through our other various interventions.

Even if it is necessary to intervene, it does not follow that market forces have no constructive role to play. As a result, intervention such as provision of risk information often is successful in ameliorating the market shortcomings that are present.

Regulation, tort liability, and social insurance also can play potentially effective roles. Regulation influences the risk, but does not effectively compensate for it. Tort liability and social insurance provide for compensation, though the levels of this compensation are seldom adequate to create efficient incentives for accident avoidance. These mechanisms are useful, particularly for risks that are not well addressed through the market. However, they do not succeed as well as a fully functioning market in addressing the pertinent risks and compensating those who are exposed to these hazards.

There is perhaps a greater tendency to excess with risk regulation than with any other form of government intervention. In some cases people are unduly complacent regarding major risks to their lives, and in others there is alarmist behaviour. The government also tends to respond in an alarmist manner, often mirroring the deficiencies of individual choices. Risk debates are often highly charged emotionally and involve dimly understood scientific evidence. The task for government policy-makers is to establish a more reasoned approach to dealing with these risks rather than institutionalising the excesses of individual behaviour.

Question Time

Ray Evans (Western Mining Corporation): Professor Viscusi, you suggested that we have regulation because of market failure. Could you elaborate on precisely what that market failure is? You also said that the ban on leaded petrol had been an unqualified good, at least in the United States. What evidence do you have to support that claim?

Kip Viscusi: As for market failure, there is often a lack of information about the risk. Even in a market, people may not be aware of a risk; for example, workers may have only a dim understanding of a health risk. Information provided to them would be useful. Similarly with drugs and pharmaceutical products, whose properties we may

not be able to detect through inspection: clinical trials give us information that we could not acquire individually. So providing information would be a way of assisting people to make better decisions. Another class of market failures has to do with externalities. Companies may make decisions that lead to air pollution, water pollution, and so on, but there's no market in which they could try to bribe or compensate the victims for the damage. As a result, the pollution levels would be too high.

As for the ban on leaded petrol, in the United States the ban has had some beneficial effects. The US Environmental Protection Agency undertook an analysis that showed in advance that the benefits of the regulations exceeded the costs. Decrease in lead exposure is the most dramatic example of decline in pollution levels in the US.

Mark Tweedale (**Australian Centre for Advanced Risk & Reliability Engineering**): Substantial pressures are pushing us towards ever more regulation. If an accident occurs because of a lack of regulation, then there is media outcry, and the regulator is in trouble. If, on the other hand, there is over-regulation, then there is very little concern, except at forums such as this one. And any move to relax the level of regulation leads to the claim that safety standards are being compromised. How can we deal with this?

Kip Viscusi: These are difficult issues to get people to deal with sensibly. The errors resulting from over-regulation receive far less attention than the dangers associated with under-regulation. In the United States, for example, the public response to a death caused by an approved drug is very different from the response to failure to approve a drug that, had it been approved, could have saved lives.

I think the best way to point out the dangers of over-regulation is to put the issue in terms of the decisions that people themselves would make. In a case of over-regulation involving spending $100m per life saved, the question to ask people is whether they would want to do this for their own purchases. If it's sensible for the government to spend a $100m per life saved, then individual consumers should be willing to spend an extra $5,000 for a car that's 10 per cent safer, or an extra $25,000 for a car that's 50 per cent safer. In reality, most people would not be willing to make those expenditures. If they were obliged to make the same trade-offs in their private decisions as the government makes in its decisions, they would protest that they were made to spend too much on safety. So the best way to convey the dangers of over-regulation is to encourage people to see that over-regulation is not a free good.

Tony Chisholm (La Trobe University): You said that one source of market failure is irrational behaviour. This is linked, I think, to market failure in respect to information. Can we reduce irrational behaviour by disseminating information better?

Kip Viscusi: People are irrational, but they tend to be irrational in systematic ways. The costs of communication include the cost of information processing on the part of the recipients. If consumers are inundated with masses of different kinds of

information, they have a problem distinguishing the significant from the insignificant. We do know how to communicate information in an individual context; for example, I can tell you how to design a good warning label. But we know less about which of the multitude of warning labels a consumer is going to see this week. There's no discipline in this provision of information to limit the amount of information we give people. Regulatory agencies and companies trying to fend off tort liability have an incentive to provide masses of information to cover themselves, regardless of the fact that the net effect is to reduce people's ability to distinguish the true risks that are present.

There is no question that, by providing risk information, we can correct people's risk beliefs. Whether risk information generally works depends on the kind of risk information provided. When the government provides information (and I haven't seen any risk information except for a few warnings for prescription drugs), it typically indicates a probability, like '50,000 people died last year in automobile accidents'. But such quantitative information is hard for people to comprehend.

The way to learn more is to run field studies with real people, to see what happens. We've done a series of studies in which we actually provide people with different types of qualitative risk warnings. Then we debrief them to see how well the warnings provide them with the correct risk judgements. We find that people can learn, but it is not as easy as you might think because you can't go out and just hand people a probability.

P. P. McGuinness (The Age): I wonder about some of the risk estimates and whether they produce useful results. In many cases, the alleged risks to life expectancy that are regulated or interfered with by government in various ways are based on fads and fashions in the medical profession, which often subsequently prove to be false. For example, 20 years ago we were told that that olive oil was high in cholesterol and therefore dangerous to use, and that margarine was much safer than butter. Both of these claims have since been proved to be incorrect. In the United States it's argued that wine, particularly red wine, is very bad for you. But there's increasing evidence that, up to quite substantial rates of consumption, red wine is actually good for you. Regulations are often based on false information.

Kip Viscusi: I agree. We typically get false information about situations in which the risks are ambiguous. If we don't really know everything about the risk, the question arises whether to propagate the existing risk information or to adopt the worst-case scenario (which we do now). But lack of full information about risks should not discourage us from taking action. Many risks will never be resolved.

In such situations of imperfect information, regulators have three choices. The first is to wait and see what the risks are. This is the approach the US is taking with respect to climate change. The second is to proceed on the basis of the available evidence. The third is to proceed on the basis of the worst possible scenario. I would advocate the second approach. Let's not use uncertainty as an excuse for inaction. By the same token, let's not use uncertainty as an excuse for irrationally focusing on the worst-case scenario.

Alan Seale (ICI): No doubt you're aware of the vigorous attack on chlorine, and chlorine-based products, by green groups, particularly in Europe and the US. How do you see that debate being played out?

Kip Viscusi: The best approach is to ask whether the use of chlorine reduces risks *on balance*. From the fact that chlorine use creates a risk, it does not follow that it shouldn't be used. The problem is that the public response to newly appearing risks, especially man-made ones, tends to be alarmist.

John Whiteman (Bureau of Industry Economics): You imply that the value of life is a function of income. Does it follow from this that we should dump all our hazardous waste in developing countries, and carry out our atomic tests in the Pacific Ocean rather than in France?

Kip Viscusi: If the less developed countries were willing to take in the hazardous waste at a price---and if the citizens, not just the people cutting the deal, knew what they were getting into---that wouldn't be a bad idea. They may be able to use the money they make out of hazardous waste storage to improve health care and other welfare services.

Mark Towler (Victorian Trades Hall Council): It has been said that slavery is the most cost-effective way to employ people. But such a practice would be devoid of any moral or social dimension. The discussion we've had so far seems devoid of anything to do with responsibility. How does the moral and social issue, the issue of the quality of life for working people, bear on the science of risk management?

Kip Viscusi: I think the best way to respect the interests of working people is to use their values to drive the policies. In trying to figure out how stringent job-safety regulations should be, I refer not to the value that a government bureaucrat or an employer would place on them, but to the value that workers themselves place on them. That's what these value-of-life numbers have attempted to do. For example, we wouldn't want to value a life at $100m, even to improve the well-being of workers, because such a high number is going to lead to unemployment: the construction industry, for example, wouldn't survive, because it wouldn't pass a benefit-cost test.

Question : A problem we have in Australia is that the parliamentary draftsmen are not very good at preparing framework legislation. Good framework regulation doesn't go into any detail, but it is necessary for creating the right atmosphere for by-laws and standards. How does the US fare in this respect?

Kip Viscusi: American legislators certainly perform worse than Australia's. Our framework legislation essentially establishes the basic principles for regulatory policy.

In the case of the Occupational Safety & Health Act, the agency was urged to provide a healthy and safe workplace for every American, but without any mention of costs or trade-offs. As a result, when the legislation was originally passed, people thought that within a few years an 80 per cent reduction in risk would occur. The same thing happened with automobile safety. It took 25 years of experience to teach the American legislators that trade-offs are involved. This year new legislation was passed focusing on mean risks and benefit-cost analysis, and generally overhauling the regulatory process.

The US differs somewhat from Australia in that American legislators are concerned with legislation, not with issuing regulations. The regulatory agencies figure out the regulation, and can do anything they like that's consistent with the legislation.

Appendix
The American Experience of Workers' Compensation

Studies in the US have found that the employer does not necessarily bear the cost of workers' compensation. Although the employer pays the premium, workers value workers' compensation benefits, and are therefore willing to accept a lower wage rate in return for these benefits. In the US we found that as the wage offset associated with workers' compensation benefits exceeds the value of the premiums, employers actually make money from workers' compensation. If there were no workers' compensation for job hazards, employers would have to pay their workers a lot more money.

But why would workers be willing to pay more than the actual cost of the benefits? For the same reason that anyone buys any insurance at all: they are risk averse. Workers value the workers' compensation benefits that they receive at more than their actuarial values. We have to be careful in calculating who actually bears the cost because there could be other market mechanisms at work.

The best-paid jobs are not necessarily the riskiest jobs. In calculating compensating differentials, one must control for educational levels and other such factors. So, other things being equal, additional job risk makes a job more highly paid. We have a lot of evidence that indicates that this is the case. There is a reason why coal miners are paid $26,000--$36,000 in Australia. They are paid a lot more than workers in McDonalds because their jobs are more onerous, more risky, and more unpleasant. These are all compensating differentials.

In the US, roughly one third of all quits on the part of workers can be traced to job risks. Workers learn about the risks on the job. If they don't like what they see, given the amount they are paid, they quit. A huge amount of labour turnover is attributable to job risks, as is much absenteeism and appeal to grievance procedures. All these mechanisms are stimulated by job risks. The market is certainly not perfect, but a lot of market mechanisms are at work.

It's been said that workers' compensation in Australia stimulated better rehabilitation management but not risk reduction, and seemed to be most effective for the least serious injuries. The US experience is exactly the opposite. The biggest effect of the workers' compensation incentives is evident from linking them to fatalities. The second biggest effect is derived from linking them to serious work injuries. No effect, on balance, is evident from linking them to the minor injuries. The reason there is no effect for the minor injuries is that when workers' compensation benefits are made more generous, workers seem more willing to report injuries; there is more false reporting of injuries; and the duration of injuries increases because it becomes more lucrative to stay out of work. In other words, there's a moral hazard problem.

About the Author

W. Kip Viscusi is George G. Allen Professor of Economics and Director of the Program on Risk Analysis and Civil Liability at Duke University. His early reputation was built on pioneering work in the estimation of the value to individuals of improvements in environmental and workplace health and safety. His estimates of the value of life and health are now widely used in the Us Federal administration.

As the author of 15 books and over 150 articles, he has since examined the entire gamut of individual and institutional responses to risk. At the level of the individual, he has explored the manner in which individuals' willingness to accept occupational risk varies systematically with their wealth and with their attitudes to other risky lifestyle options. More recently he has provided new insights into the accuracy with which individuals' risk perceptions mirror the objective risks that they face. At the level of social choice, Kip Viscusi's books, *Fatal Tradeoffs* and *Reforming Products Liability*, offer a uniquely comprehensive evaluation of the strengths and weakness of alternative approaches to the regulation of risk.

He is founding editor of the *Journal of Risk and Uncertainty* and serves on the editorial boards of seven other professional journals, including the *American Economic Review*..

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W. Kip Viscusi

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