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Sources of Inconsistency in Societal Responses to Health Risks

By W. KIP VISCUSI*

Society responds in extreme and often inconsistent ways to health risks. In many instances, the pattern observed is one of overreaction. The Tylenol tampering incidents of the early 1980s drastically reduced the national sales of this product, even though the seven reported deaths were all in the Chicago area. Isolated terrorist incidents periodically choke off the consumer demand for European travel, and the Food and Drug Administration banned the sale of tens of millions of dollars of Chilean fruit based on evidence of low levels of cyanide injected into two grapes. More generally, there is evidence that individuals respond in an alarmist manner to increases in the risks they face, even though these increases may be rather small.

Although one might be tempted to generalize from such events to conclude that there is always universal overreaction to risk, other patterns of behavior reflect errors of the opposite type. Individuals continue to fail to wear seatbelts as often as they should given the health benefits and the costs involved (see Richard Arnould and Henry Grabowski, 1981). Similarly, society has until recently devoted insufficient attention to the long-run environmental problems that we face, including acid rain and the greenhouse effect. Our inaction with respect to these risks can hardly be characterized as a rational response or an overreaction to risk.

There are three possible explanations of such diverse phenomena. First, one could simply dismiss this behavior as being the result of inconsistent and irrational behavior. Second, one could devise *ad hoc* explanations of why individuals underreact in some instances and overreact in others. A

third possibility is to reconcile this seemingly inconsistent behavior with a consistent theoretical framework. In this paper, I follow the third approach in which I discuss new results that indicate how the character of individual risk perceptions can generate inconsistent patterns of response.

I. The Pattern of Risk Perceptions

The genesis of my approach stems from the relationship between perceived and actual risks. Figure 1 sketches the relationship that has been borne out in studies of risk perception. At probability levels below F_0 , individuals tend to overestimate the risk level, whereas for large risks above F_0 , there is a tendency toward underestimation. Individuals consequently exaggerate the risks posed by rare events, such as the chance of being hit by lightning, and underassess the truly major risks, such as the chance of death by heart attack or stroke. In addition, the discontinuity of preferences at the zero-risk level indicates that there will be a substantial jump in the perceived risk level once the risk rises from being zero to some nonzero level of risk.

I have incorporated this basic pattern of risk perception within a general theory of decision making under uncertainty, which I have termed "prospective reference theory" (see my 1989 paper). The principal modification in standard choice models is that one replaces the individual's actual probability q with some perceived probability $\pi(q)$. For example, using a *beta* probability distribution, if q is the risk of an accident, then we can write $\pi(q) = (\alpha p + \delta q) / (\alpha + \delta)$, where p denotes the reference risk level, q denotes the risk associated with the particular event, α is the informational content associated with p , and δ is the informational content associated with q .

*George G. Allen Professor of Economics, Duke University, Durham, NC 27706.

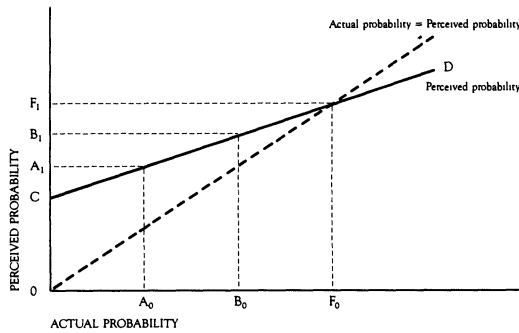


FIGURE 1. RELATION BETWEEN STATED AND PERCEIVED PROBABILITIES.

This formulation is consistent with a Bayesian learning model in which the reference risk p corresponds to the decision maker's prior probability assessment. In the context of accidental death risks, this probability could, for example, be the average risk being addressed in the survey. In the context of laboratory experiments, the probability associated with the lottery outcome could be the probability that would prevail if the respondent did not take the experiment description as being fully informative, but instead placed some weight on a prior in which all outcomes in a lottery were equally likely.

Application of this approach to the anomalies that have been observed in the literature produces quite powerful results. One can reconcile a large and diverse array of types of irrational behavior with the standard expected utility model upon making this transformation. Moreover, what is most striking is that this formulation *predicts* such behavior as opposed to being potentially consistent with these anomalies. For example, the methodology predicts that the Allais Paradox will prevail, that there will be a certainty effect in which individuals value risk reductions that achieve complete certainty more greatly than they should, and many other prominent violations of the standard expected utility theory.

II. Implications for Risk-Taking Behavior

Consider a binary lottery situation in which an individual faces a probability q of injury or death and a probability of $1-q$

of remaining healthy, where the perceived probability is given by $\pi(q)$. In the good health state, utility is given by $U(I)$, and in the ill health state, utility is given by $V(I-L)$, where I is the income level and L is a monetary loss (possibly 0) associated with ill health. For any given level of income, the individual is assumed to rather be healthy than not and to be risk averse. I will also assume that the marginal utility of income is at least as great when healthy as when one is not, which has been borne out empirically in the case of job risks (see my paper with William Evans, 1990).

Let Y be the compensation such as a price cut for a risky product, or a wage premium for a hazardous job that is necessary to maintain the individual's expected utility level at U_0 , or

$$(1) \quad U_0 = (1 - \pi(q))U(I + Y) + \pi(q)V(I + Y - L).$$

The first tradeoff that will be considered is how the required compensation Y varies with the extent of the loss. Total differentiation of equation (1) yields the result that

$$(2) \quad \frac{dY}{dL} = \frac{\pi(q)V'}{(1 - \pi(q))U' + \pi(q)V'} > 0.$$

As the loss increases, the required compensation Y rises. The more important issue is the extent to which dY/dL is altered by the introduction of perceptual biases. For situations in Figure 1 in which q is below F_0 , $\pi(q)$ will exceed q , implying that dY/dL will be increased by the biases in risk perception for small risks. Similarly, the required compensation will be decreased by the perceptual biases for high risk levels.

The analogous result for the effect of changes in the risk level q are somewhat more complex, and it is more instructive to consider them within the context of concrete economic actions that will alter the risk level. In particular, suppose that we have opportunities both for insurance and self-protection. In the case of self-protection, one can take a precautionary expenditure c that will influ-

ence the risk component q , but the reference risk component p will be unaffected so that we have $\pi(q(c)) = (\alpha p + \delta q(c))/(\alpha + \delta)$. In addition, one can choose to purchase an amount of insurance x for a unit price of s , leading to the optimization problem

$$(3) \quad \text{Max}_{c, x} Z = (1 - \pi)U(I - sx - c) + \pi V(I - L - sx + x - c).$$

The condition for optimal insurance is given by

$$(4) \quad U' = (\pi/q)((1-s)/(1-\pi))V'.$$

Consider the actuarially fair insurance case, where $s = q$. For $\pi(q) > q$, the right-hand side of equation (4) will be larger than in the unbiased case, implying that a lower marginal utility of income in state 2 is needed to establish the optimal insurance amount. A lower marginal utility of income is associated with a higher level of insurance, so that for the risk levels below F_0 in Figure 1, there will be an incentive to overinsure as compared with the unbiased case. For the points above F_0 , there will be an incentive to underinsure.

Risk perception biases have a more complex effect on safety precautions. The requirement for optimal self-protection is that

$$(5) \quad -dq/dc = \frac{\alpha + \delta}{\delta} \frac{[(1 - \pi(q))U' + \pi(q)V']}{(U - V)}.$$

The value $-dq/dc$ indicates the marginal productivity of precautionary behavior in influencing the risk level.

The requirement on the marginal productivity of safety precautions as reflected in the right-hand side of equation (5) is affected in two ways by perceptual biases. The informational content term $(\alpha + \delta)/\delta$, that exceeds 1.0, induces a lower level of precautions by requiring a higher marginal productivity $-dq/dc$. In situations of optimal insurance ($U' = V'$), the net effect will be to

diminish the level of precautions selected. When there is not full insurance, the results become more ambiguous because the effect of the risk perception biases on the level of insurance and the expected marginal utility of income hinge on how much marginal utilities are altered when one departs from the optimal insurance amount, and on whether the size of any such effect outweighs the role of the informational weight term. If, however, the dominant effect is that the biases in risk perceptions raise the required marginal productivity of safety expenditures, as in the optimal insurance case, then risk perception biases will always reduce precautionary expenditures.

The nature of the different influences can be summarized using Figure 1. Overall attitudes toward risk and the desirability of insurance will be governed by the relationship between the perceived and actual probabilities. For $q \leq F_0$, risks are overestimated, and there will be a tendency to overinsure and to be overly cautious in discrete responses to risk. For large risks, $q > F_0$, the reaction will be the opposite. From the standpoint of continuous choices affecting safety, however, what is primarily relevant is the slope of CD, not the level of the probability, although this continues to enter the expected marginal utility. Since the perception function $\pi(q)$ flattens out the relationship between perceived and actual probabilities, the marginal efficacy of safety expenditures is reduced. A precaution that reduces a risk from B_0 to A_0 in Figure 1 has a more modest effect of reducing the perceived risk from B_1 to A_1 . The risk perception function consequently mutes the perceived impact that safety precautions will have for all levels of risk.

These different competing effects indicate why one might have quite conflicting reactions to the same level of risk. Why, for example, do we respond in often alarmist ways to the various low probability health risks that are called to our attention, yet we fail to take appropriate safety precautions, such as seatbelt use, that are available to us? Although a variety of explanations are possible, the character of the risk perception biases, alone is sufficient to explain these

seemingly contradictory phenomena. The level of the risk may be overestimated, but the risk perception function may also serve to dampen the perceived efficacy of safety precautions, so that when we have available actions offering incremental reductions in risk, we underrespond.

Although this conclusion is true for marginal changes in riskiness, if there are available strategies that will completely eliminate the risk, then there will be no such dampening in the response. In particular, if we can reduce the risk to zero, we not only obtain a value of the marginal perceived risk reduction probability along *CD*, but we also achieve the additional bonus in terms of the perceived risk reduction of *OC*. Thus, there will be a predilection for policies that achieve the complete certainty of risk reduction. This predilection is borne out in studies of consumer evaluation of product safety, as consumers are willing to pay much more for the final incremental reduction in risk to zero than they are for the earlier risk reductions of equal magnitude, even though economic theory would predict the opposite. Stringent government regulations, such as the Delaney Clause's requirement that no nonzero carcinogenic food additives be permitted, is likewise consistent with this orientation.

The character of the bias is dependent on the nature of the risky decision. Individuals tend to overreact to identified increases in the risk level from its accustomed amount. The study of consumer valuation of product safety by myself with Wesley Magat, and Joel Huber (1987), found that individuals were willing to pay moderate amounts for product risk reductions of 15 injuries per 10,000 bottles of insecticide or toilet bowl cleaner used per year, but when faced with a product risk increase of 1/10,000 most consumers were unwilling to buy the product at all, and those that were demanded a considerable price discount. In this context, the risky choice focused on changes in the risk from the current risk reference point to which consumers had become accustomed. In the case in which consumers are focusing on the risk increase of a product, the jump in the perceived probability indicated by the segment *OC* in Figure 1 is the pertinent per-

ceived risk increase from a marginal shift in the product risk. Even if there were a risk decrease of similar magnitude to the risk increase, there would be no reason to believe that consumers would respond in symmetric fashion, because the reference risk probability *p* that individuals have with respect to the risks posed by product improvements as opposed to deteriorations in product quality may be quite different.

III. Discounting Deferred Effects

The decision problems that individuals face involving risk are compounded by the task of appropriately discounting these outcomes. Although it has long been speculated that individuals behave myopically, there is no systematic evidence that this is the case. Studies of worker valuations of death risks (such as my paper with Michael Moore, 1989) indicate that the implicit rates of interest with which workers discount the years of life at risk on the job are consistent with rational behavior. Our point estimates of the implied discount rates are in the vicinity of 11 percent, which is somewhat high, but the standard errors on these estimates are sufficient to include other market reference points, such as prevailing mortgage interest rates.

In many respects, examining revealed preferences toward risks to their welfare at different periods of time may represent a best-case scenario. A more important issue from the standpoint of policy is how we will address effects that will not simply influence our own well-being, but also that of our children and future generations. The U.S. Office of Management and Budget (1988) has long specified a 10 percent rate of discount as the main reference point for such calculations—an approach that will drastically reduce the attractiveness of policies such as those that reduce cancer risks, or have long-term implications for our ecological well-being.

Although there have been a variety of battles over the appropriate discount rate, insufficient attention has been paid to the implications of the productivity assumptions that underlie such discount rate estimates. In particular, if the appropriate rate of discount

is in fact 10 percent, then the rate of expected productivity growth in the economy also must be quite substantial to justify such a high rate. This growth will boost the income of future generations, which in turn will raise the value that they attach to the risk reduction benefits. Recent estimates by myself and Evans (1990) indicate that the elasticity of the implicit value of job injuries with respect to income is 1.0, and if this relationship generalizes to other health impacts, then it implies that an increase in income will increase the risk reduction benefit values proportionally. Valuing health risks through use of high discount rates should not drastically affect the attractiveness of policies with long-term implications, provided that the benefit values are adjusted appropriately.

Perhaps the main shortcoming is that individuals are likely to place an inefficiently low weight on benefits to future generations. Moreover, our social institutions have thus far proven to be very poor at long range planning, as there is a predilection for responding to more imminent crises. Indeed, if it had not been for the hot summer of 1988, it is unlikely that addressing the greenhouse effect would even be on our national agenda.

As in the case of risk perception biases, the most disturbing aspect of these potential market failures is that the government poli-

cies intended to eliminate the shortcomings often appear to be driven by the same set of influences.

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