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by

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To Reduce Environmental Risk

I. Introduction and Overview

In the U.S. during the 1970's several incidents focused public attention on the risks to health from the improper disposal of toxic waste. Contamination of soil and groundwater were the result of leaking barrels stored above ground or buried in unlined (and frequently clandestine) disposal sites. Depending on the type and concentration of toxics involved, families and in some instances communities were advised to switch to bottled water for drinking and food preparation until concentrations of the contaminants could be reduced or an alternative supply of water found and connected to the distribution system.

In 1980 the passage of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) assigned to the Environmental Protection Agency (EPA) the tasks of identifying active and abandoned disposal sites, cleaning-up or providing safe storage of wastes at those sites, and regulating the generation, transport and disposal of all future toxic wastes. CERCLA created a $1.6 billion "superfund" to be used for the cleanup of the worst sites. Even that amount may be insufficient. As of October, 1985 a total of 850 sites have been identified and given "national priority". A recent study, commissioned by the National Campaign Against Toxic Hazards, has criticized the speed and methods employed by the EPA. The study goes on to recommend that $10 billion be allocated over the next five years to provide for a more adequate cleanup effort (New York Times, September 15th, 1985, Section 1, p. 37).

Programs to cleanup existing sites and to regulate future disposal will presumably reduce the risk to public health from contaminated drinking water.

Economists have studied the behavior of individuals faced with risks to life and health and have struggled with the problem of evaluating both public and private actions that save lives or reduce the threat of bodily injury (see, for example, Mishan 1971, Ehrlich and Becker 1972, Zeckhauser 1973, Jones-Lee 1974, Conley 1976 and Cook and Graham 1977). Of importance to the individual, and thus to the government, is the extent to which insurance or self-protective actions allow individuals to reallocate wealth contingent on "future states of the world". For the case at hand, the future might be partitioned into two future states: continued good health or ill-health (induced by the improper disposal of hazardous waste). Insurance might allow the individual to contract for a disability payment contingent upon the state "ill-health". In addition the individual might take self-protective actions (for example, purchasing bottled water, installing filters, or moving) which would allow the individual to modify his or her subjective assessment of the health risk.

The objective of this paper is to explore the value of government (collective) actions to reduce risk when individuals have only an imperfect ability to modify subjective probabilities via self-protective actions. Cook and Graham and more recently Gallagher and Smith (1985) consider the problem of evaluating a reduction in the probability of an adverse state when the individual faces a set of perfect markets for purchasing insurance, or equivalently, markets for contingent claims. With perfect markets it is possible to develop upper and lower bounds on the value of an incremental reduction in the probability of an adverse state. This analysis is briefly reviewed in the next section.

In the absence of perfect markets for contingent claims it would not appear possible to place theoretical bounds on the value of reducing the probability of an adverse state. It is possible to conceptually identify the value of reducing the risk of an existing hazard and it turns out to be an option price. This measure is developed in a model where subjective probability is conditional on the individual's self-protective action and the government's collective action (or inaction) in the treatment or storage of the hazardous waste. The details of this measure are presented in Section III.

The fourth section examines the implications of option price as a concept for empirically evaluating programs to reduce environmental risk. The method of "contingent valuation", used to evaluate environmental amenities, would appear to be a promising technique for evaluating programs to reduce risk. Contingent valuation encompasses a set of techniques where an individual or household is asked directly or induced to reveal their willingness-to-pay for a change in the attribute of an environment, situation or activity. Such techniques have been used in valuing improving visibility from reduced air pollution (Rowe et al. 1980), improved wildlife habitat (Hammack and Brown 1974) or hunting conditions (Bishop and Heberlein 1979). While contingent valuation techniques are subject to potential bias (see Schulze et al. 1981) comparison with value estimates obtained from market measures (reflecting actual behavior) has not revealed the potential bias to be particularly troublesome. In the situation where toxic waste poses a threat to public health a series of questions is proposed which would provide estimates of an individual's option price, cost savings and reduced risk. While the aggregation of option price values across individuals may be subject to question on both conceptual and ethical grounds it is likely to provide a lower bound estimate on the benefits of a government program to reduce environmental risk.

II. The Value of Reduced Risk with Perfect Markets

Consider a simple two-state model based on the following notation:

H_s = health in state s, s = 1,2, where H_1 denotes a deterioration to ill-health in state one while H_2 denotes continued good health in state two,

W = income or wealth,

$U(W,H_s) = U_s(W)$ = a state-dependent von Neumann-Morganstern utility function, and

p = the subjective probability of health deterioration resulting from the environmental hazard.

It is assumed that $U_1(W) < U_2(W)$ for all $W \geq 0$ and that $U_s''(\cdot) < 0 < U_s'(\cdot)$ (strict concavity) for s = 1,2.

Cook and Graham introduce two wealth dependent measures: compensation and ransom. Compensation, C(W), is the minimum amount the individual would require to exchange a <u>known</u> (certain) state of good health for a known state of ill-health. It is defined by

$$U_1(W + C(W)) = U_2(W) \quad . \tag{1}$$

Ransom, R(W), is the amount an individual would be willing to pay to exchange a known (certain) state of ill-health for a known state of good health and is defined by

$$U_1(W) = U_2(W-R(W)) \quad . \tag{2}$$

It is typically assumed that $R(W) \leq W$. There need not be a least upper bound on C(W) and $C(W) \to \infty$ for ill-health leading to death (or conditions which might be considered worse than death).[1]

Careful inspection of Figure 1 will reveal the following relationship between compensation and ransom:

$$C(W - R(W)) = R(W) \, , \tag{3}$$

$$C(W) = R(W + C(W)) \, . \tag{4}$$

In words, the compensation payment when your wealth is $W - R(W)$ is equal to the ransom payment when your wealth is W, and the compensation payment when your wealth is W equals the ransom payment when your wealth is $W + C(W)$. Thus compensation and ransom measures differ only by a wealth effect.

Taking the derivative of (2) we can solve for $R'(W)$ obtaining

$$R'(W) = 1 - U_1'(W)/U_2'(W-R(W)) \tag{5}$$

Cook and Graham proceed to distinguish between a "replaceable" commodity and an "irreplaceable" commodity based on $R'(W)$. If a commodity, say an assembly line automobile, is replaceable it will have a given market price and the ransom payment $R(W)$ is invariant with respect to wealth and thus $R'(W) = 0$. An irreplaceable commodity (perhaps a family heirloom or work of art) may not have a perfect substitute and the ransom payment that an individual would make would likely depend on his level of income. Thus $R'(W) \neq 0$ for an irreplaceable commodity. Cook and Graham go on to distinguish between a <u>normal</u> irreplaceable commodity and an <u>inferior</u> irreplaceable commodity by defining a commodity to be

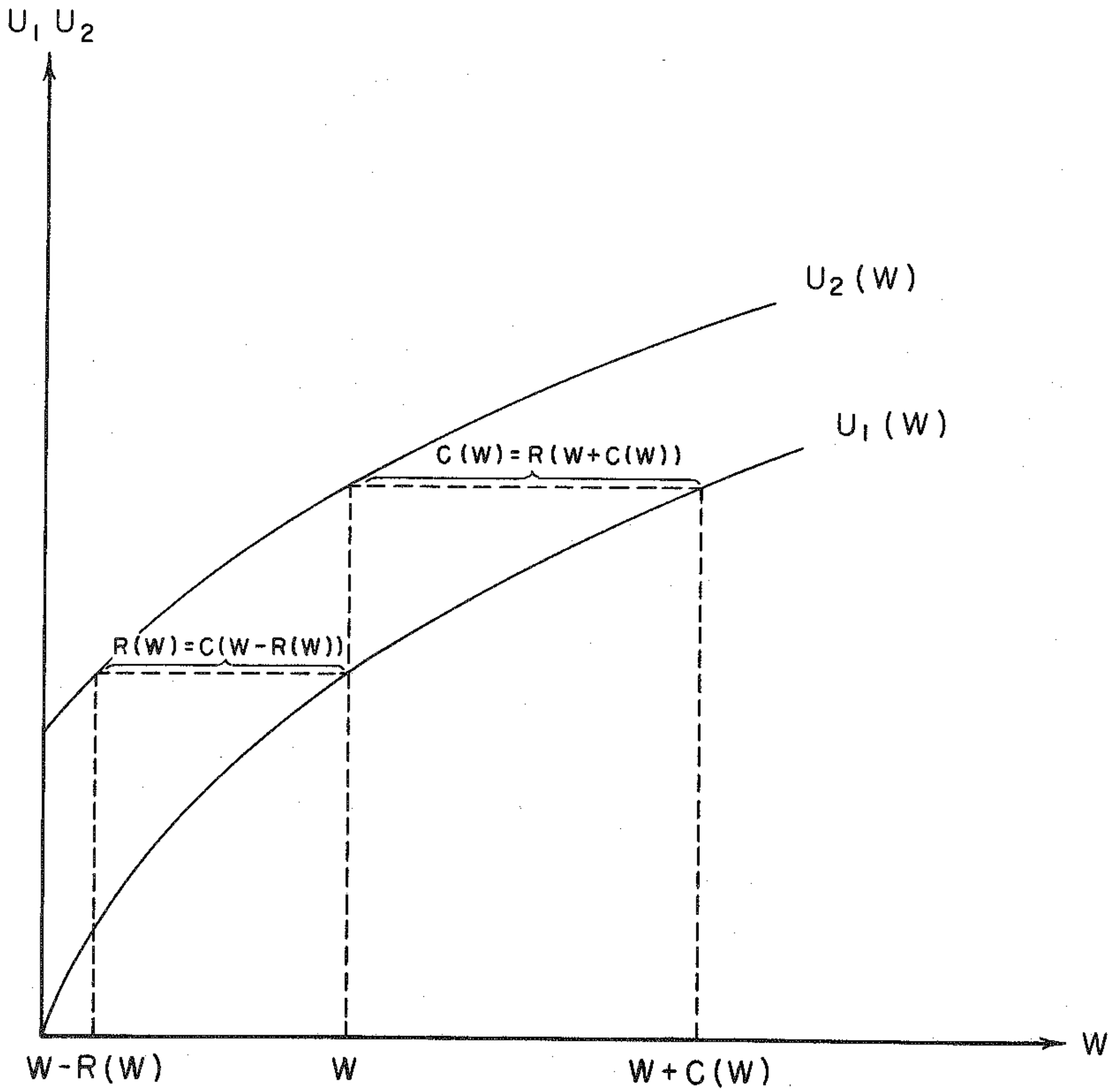
$$\text{inferior} \quad \text{if } R'(W) < 0 \, , \tag{6}$$

$$\text{normal} \quad \text{if } R'(W) > 0 \, .$$

From (5) we note that if

1/ Gallagher and Smith note that C(W) and R(W) correspond to the more traditional Hicksian notions of equivalent surplus, and compensating surplus, respectively. Thus Cook and Grahams "compensation" is an equivalent surplus measure.

FIGURE 1. COMPENSATION AND RANSOM



$$R'(W) > 0 \text{ , then } U_1'(W) < U_2'(W - R(W)) \text{ and } C(W) > R(W) \text{ ,}$$ [2]

$$R'(W) = 0 \text{ , then } U_1'(W) = U_2'(W - R(W)) \text{ and } C(W) = R(W) \text{ ,} \qquad (7)$$

$$R'(W) < 0 \text{ , then } U_1'(W) > U_2'(W - R(W)) \text{ and } C(W) < R(W)$$

Consider the situation faced by an individual with wealth endowments W_s^o , $s = 1,2$. The expected value of his initial endowment is

$$W^o = pW_1^o + (1-p)W_2^o \qquad (8)$$

With access to perfect markets for reallocating wealth between future states the individual is assumed to maximize expected utility subject to the constraint that the new allocation W_s^* , $s = 1,2$, has the same expected value as the initial endowment. By a perfect or "fair" market we mean a market where the ratio of subjective probabilities equals the ratio of contingent commodity prices.[3] In such a world the maximization problem becomes

$$\underset{W_1,\, W_2}{\text{maximize}}\ pU_1(W_1) + (1-p)U_2(W_2) \qquad (9)$$

$$\text{subject to } W^o = pW_1 + (1-p)W_2$$

with first order conditions that imply

$$U_1'(W_1^*) = U_2'(W_2^*) \qquad (10)$$

for the optimal "portfolio" of contingent claims (W_1^*, W_2^*). Define expected utility U^* as

$$U^* = pU_1(W_1^*) + (1-p)U_2(W_2^*) \ . \qquad (11)$$

From the maximization problem it is clear that W_1^* and W_2^* depend on p and W^o.[4]

2/ Note that if $R'(W) > 0$ then $R(W) < R(W + C(W)) = C(W)$.

3/ If r_1 and r_2 are the per unit prices for a unit of W in state one and two, respectively, then a fair market will have the characteristic that the ratio of subjective probabilities will equal the ratio of prices for contingent claims; ie $p/(1-p) = r_1/r_2$ (see Gallager and Smith 1985).

4/ This is analogous to deriving commodity demand curves which depend on prices and income.

Define $W(p)$ as expected wealth where

$$W(p) = pW_1^*(p) + (1-p)W_2^*(p) \quad . \tag{12}$$

Then there exists an indifference curve depicting the trade-off between expected wealth and p so that expected utility is maintained at U^*. For a reduction in p, the probability of the adverse state, $W(p)$ will be reduced in order to maintain expected utility at U^*. Conversely an increase in p would necessitate any increase in $W(p)$ to preserve U^*. This indifference curve is drawn in Figure 2. Its curvature reflects the fact that $W'(p)$ and $W''(p)$ are nonnegative.5/

Suppose that the initial probability of the adverse state was p° and that the expected wealth from equation (12) is $W^\circ = W(p^\circ)$. The value of a small reduction in p° is the slope of the indifference curve and is denoted as

$$V \equiv W'(p^\circ) \tag{13}$$

Taking the total derivative of (11) and (12) and noting $U_1'(\cdot) = U_2'(\cdot)$ yields

$$V \equiv W'(p) = W_1^* - W_2^* + [(U_2(\cdot) - U_1(\cdot))/U_2'(\cdot)] \tag{14}$$

The term $(W_1^* - W_2^*)$ represents the maximum amount an individual with initial wealth $W(p^\circ)$ and a certainty of state one (ill-health) would be willing to pay for a lottery involving a probability of p° for state one , $(1-p^\circ)$ for state two and the ability to purchase contingent claims in a perfect market. For an irreplaceable asset such as health the second term $[(U_2(\cdot) - U_1(\cdot))/U_1'(\cdot)]$ is positive and reflects the differences between existence with good health versus ill-health. If the asset were replaceable this second term would be zero.

The value of an incremental reduction of p° will be bounded by the measures $R(W)$ and $C(W)$.

Examine Figure 3. Note

5/ See Cook and Graham (1977, p. 154).

FIGURE 2. THE TRADE-OFF BETWEEN p AND W(p)

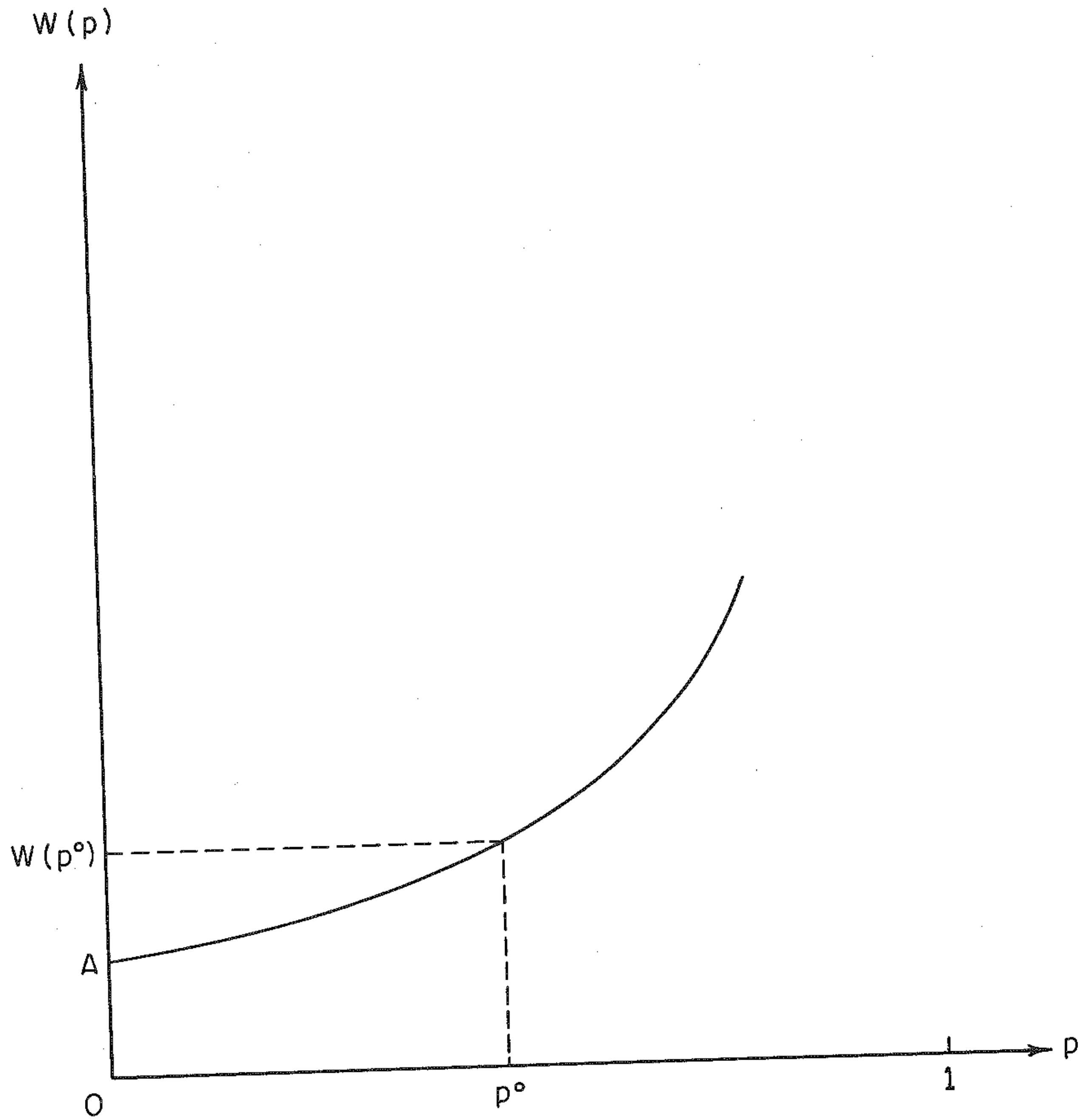
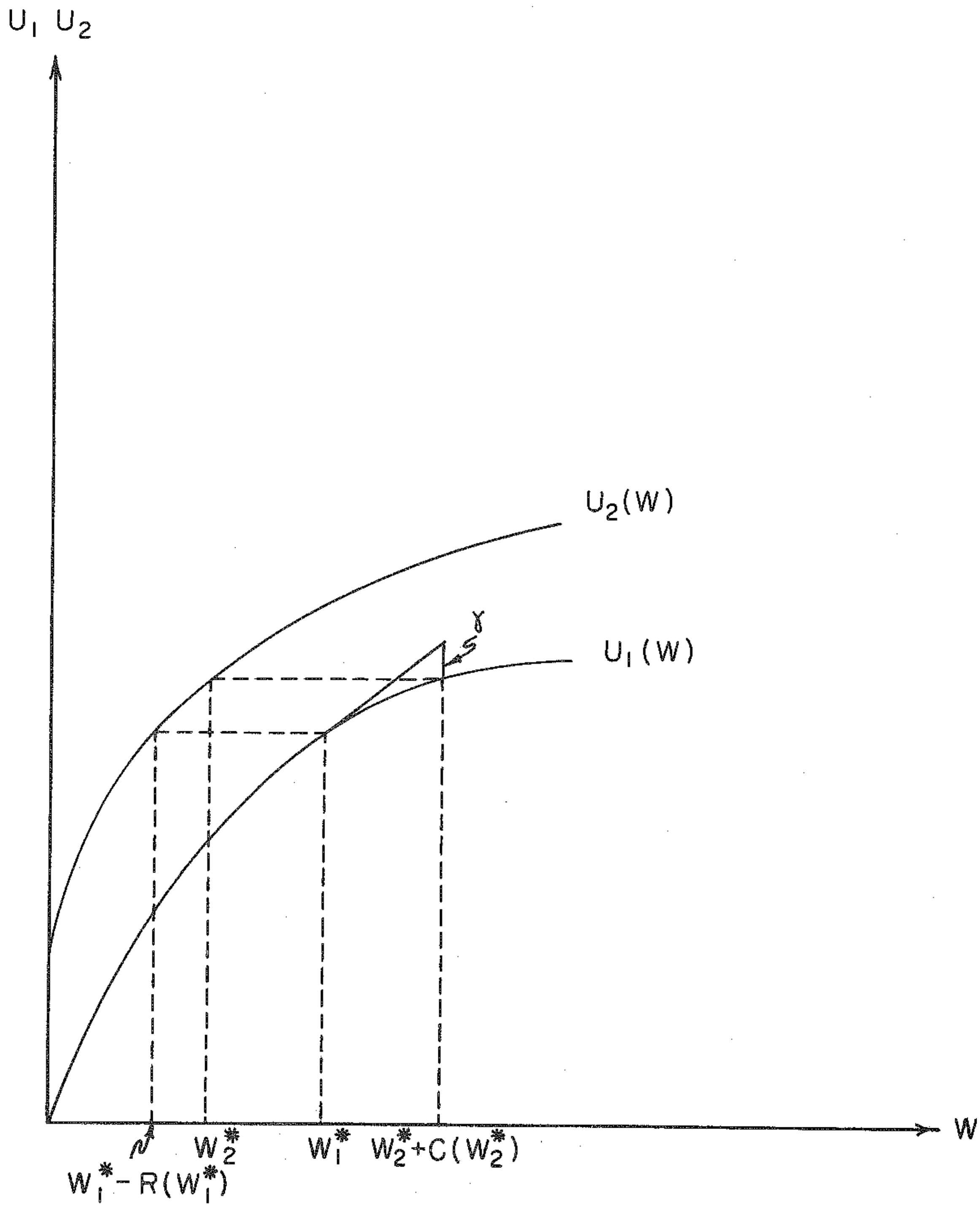


FIGURE 3. BOUNDS FOR V.



$$U_2(W_2^*) = U_1(W_2^* + C(W_2^*)) < U_1(W_1^*) + (W_2^* + C(W_2^*) - W_1^*)U_1'(W_1^*) \quad (15)$$

The right-hand-side of the inequality is the height of the tangent from $(W_1^*, U_1(\cdot))$ at $W_2^* + C(W_2^*)$. The difference is depicted as γ in Figure 3. Manipulation of (15), and noting $U_1'(\cdot) = U_2'(\cdot)$ with perfect markets, results in

$$V = W_1^* - W_2^* + (U_2(W_2^*) - U_1(W_1^*))/U_2'(W_1^*) < C(W_2^*) \quad (16)$$

In a similar fashion

$$U_1(W_1^*) = U_2(W_1^* - R(W_1^*)) < U_2(W_2^*) + (W_1^* - R(W_1^*) - W_2^*)U_2'(W_2^*) \quad (17)$$

Manipulation of (17) leads to

$$V = W_1^* - W_2^* + (U_2(W_2^*) - U_1(W_1^*))/U_1'(W_1^*) > R(W_1^*) \quad (18)$$

Thus Cook and Graham conclude

$$(W_1^* - W_2^*) < R(W_1^*) < V < C(W_2^*) \quad (19)$$

for a normal irreplaceable commodity. The expression obviously holds when $C(W_2^*) \to \infty$ (illness worse than death).

Gallagher and Smith note that these bounds only hold when the individual has access to perfect contingent claims (insurance) markets. In the case of environmental amenities in general and health risks from toxic wastes in particular such markets do not exist. Instead the individual faces a complex situation of imperfect insurance markets, self-protective actions, and possible governmental (collective) action. We now consider this more complex case.

III. Imperfect Markets, Self-Protection and Government Action

Suppose our representative individual faces a limited market for general health insurance with no specific coverage for ill-health induced by the environmental hazard. It is assumed, however, that the individual can take certain self-protective actions specific to the environmental hazard. With respect to toxic wastes this might involve the relatively low cost action of purchasing bottled water, the higher cost of seeking access to an alternative water distribution system or the high cost action of selling one's residence and moving to a new, less hazardous, environment. Let A represent this set of finite self-protective actions and a_i be the i^{th} action in that set, $i = 1, 2, \ldots, I$. Also included in A is the option of doing nothing.

Let G be the set of government actions. For simplicity we will assume that the government does nothing or embarks on a specific project, g, which is thought to reduce the health risk or at least not increase it.[6/] Thus, $G = \{0, g\}$, where $G = 0$ indicates a government policy of doing nothing.

As before we will let H_s indicate the individual's health in state s where $s = 1$ indicates a deterioration to ill-health and $s = 2$ indicates continued good health. We will continue to assume that the health effect can be represented by a state-dependent von Neumann-Morganstern utility function such that $U(W, H_s) = U_s(W)$.

The individual has subjective probabilities over future states of health but in contrast to the analysis by Cook and Graham and Gallagher and Smith it is assumed that these probabilities are conditional on <u>both</u> the (private) self-protective action and the (collective) government action. In particular let $p(s|A,G)$ denote the probability of state s given a self-protective action from set A and a government action from set G. From a statistical point of view $p(\cdot)$ is a two-parameter probability distribution.

Finally, let c_i be the cost of the i^{th} self-protective action. It is assumed that this cost is contracted for prior to the realization of the state

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6/ The latter case is not as far fetched as it may seem. Some environmental scientists and public health officials fear that actions to remove toxic wastes, if improperly done, may expose residents to a higher risk than if the wastes are left in situ.

of health and is deducted from the wealth in each state. Thus, $W_s - c_i \geq 0$ is the net wealth in state s.

Consider first the problem of the individual maximizing expected utility without any government action (G=0). The problem becomes

$$\underset{a_i \in A}{\text{maximize}}\ U = \sum_{s=1}^{2} p(s|a_i,0)\ U_s(W_s - c_i) \tag{20}$$

The problem would be solved by evaluating (20) for all elements a_i and choosing that action yielding the largest value of U. Suppose there is a unique maximum and denote it a_i^o and the resulting level of expected utility as U^o. Note: the values W_s are assumed given and not subject to reallocation via insurance or contingent claims.

Consider the same problem but now with the government program, G = g. The individual wishes to

$$\underset{a_i \in A}{\text{maximize}}\ U = \sum_{s=1}^{2} p(s|a_i,g)\ U_s(W_s - c_i) \tag{21}$$

Assume that enumeration reveals a unique solution a_i^g with expected utility U^g. Suppose $U^g > U^o$. What would be the value of the government program? In this case it would be V where

$$U^o = \sum_{s=1}^{2} p(s|a_i^g,g) U_s(W_s - c_i^g - V) \tag{22}$$

The benefit of the government program is an option price (Graham 1981, p. 717), a payment made with certainty (ie regardless of the realized state of health). It has two components: (1) potential savings in the form of lower cost self-protection and (2) reduced risk of the adverse state. If $S = c_i^o - c_i^g \geq 0$ then the benefit of risk reduction is given by

$$B = V - S \geq 0 \; . \tag{23}$$

If $V > 0$, but the individual maintains the same self-protective action ($a_1^o = a_1^g$, implying $S = 0$) then the value of the project is purely risk reducing ($B = V$). If $V = S > 0$, then $B = 0$ and the project's benefits are simply cost savings from the individual's point of view. With $G = g$ the individual adopts a_1^g where $p(s|a_1^o,0) = p(s|a_1^g,g)$ for $s = 1,2$.7/ It is more likely to be the case that $G = g$ will result in V, S and B all positive.

This analysis assumes that the initial situation is one where the individual is confronted by the health risk. The measure V is likely to be less than a ransom value, since that value was the amount the individual would be willing to pay to avoid the state of ill-health with certainty. In this case the government project may not be perceived as reducing the probability of the adverse state to zero. In fact the individual may regard the government project as worthless ($V=0$, $p(s|a_1^o,0) = p(s|a_1^o,g)$ for $s = 1,2$).

While simple, this formulation is not without empirical significance. A set of methods, now referred to as "contingent valuation techniques" would seem suitable for estimating the option price which individuals would have for a government project to reduce collective risk.

IV. Option Price and Contingent Valuation

Contingent valuation techniques attempt to evaluate nonmarket attributes by the posing of hypothetical situations and then asking the individual directly for his or her willingness-to-pay (WTP) for the situation with the attribute, or by asking how they would modify their behavior and trying to impute a value for the attribute. For example, a hunter might be asked to

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7/ In this case $c_1^o = V + c_1^g$.

state his willingness-to-pay for a permit to hunt in an area with a high probability of shooting some specified number of waterfowl (Bishop and Heberlein 1979). A camper or backpacker might be shown pictures of an area with or without pollution (or equivalently, with improved visibility) and asked to state their maximum WTP for the less polluted state (Rowe et al. 1980). Finally a hiker might be informed that a particular park was closed because of congestion. Where would they go and what would they do as their next best recreational activity? Determining the behavioral response (ie, the increased cost in time and travel) might afford an estimate of the value to the marginal hiker denied admission to the congested park.

Those skeptical of contingent valuation techniques have noted that "If you ask a hypothetical question, you get a hypothetical answer." The implication being that the answer may bear little relation to the individual's "true" valuation. Practitioners of contingent valuation will readily admit that the response obtained from an individual is subject to potential bias. There are at least five sources of potential bias: (a) strategic (b) information, (c) instrument, (d) hypothetical, and (e) traditional survey (Schulze et al. 1981).

Strategic bias results if the interviewee feels it to be in his or her self-interest to deliberately misstate their preferences (WTP). Such a motive might arise if the individual hoped to become a "free-rider". Empirical evidence from three studies does not support the presence of strategic bias (Bohm 1972, Scherr and Babb 1975, and Smith 1977).

Information bias could result from the interviewee's inability to evaluate the costs and consequences of the hypothetical state or the costs of potential substitute activities or self-protective actions. Nonmarket, and in the case of hazardous waste, low probability outcomes are difficult to evaluate because of little or no experience with the hypothetical situations under consideration. In other situations, individuals might change their response (WTP) based on whether the previous bid was sufficient, along with the bids by others, to effect some environmental change. Information bias would appear to be a more difficult bias to assess and account for when applying contingent valuation techniques.

Instrument bias arises if the mechanism (the questions themselves or the way in which any payment might be paid) influences the respondent's stated WTP. For a public good or environmental attribute the stated WTP might differ if the individual were asked to pay in the form of a higher entrance fee or a tax. A second type of instrument bias is starting-point bias. In bidding-game variants an individual is asked if he or she would be willing to pay X dollars. If the answer is "yes" the next question asks if the individual would be willing to pay $\$(X+\delta)$, then $(X+2\delta)$, etc. Where the interviewer starts the process may influence where the respondent stops it (ie their highest WTP). The presence and significance of instrument bias was mixed in the empirical studies reviewed by Schulze et al.

Hypothetical bias arises if the future states of the world are ill-defined, not understood, or regarded as implausible. A question like "How much would you be willing to pay for safe drinking water?" may be too vague, while the question "How much would you be willing to pay for a reduction in the concentration of polychlorinated biphenyls (PCBs) from 0.45 parts per billion to 0.35 parts per billion?" may be too specific. In either case the contingent valuation (WTP) may be an inaccurate measure of the individual's value for a particular government program. The ability to describe future states in an accurate and meaningful way is obviously critical to the validity of the contingent valuation approach. No empirical studies, of which the author is aware, have tested for this bias.

Finally, as with any survey or interview, a contingent valuation study may be subject to sampling bias, non-respondent bias, and interview bias. In combination with the previous four sources of bias skeptics and cynics would seem to have ample ammunition with which to shoot down any contingent valuation study of nonmarket attributes. In reviewing six of the better empirical studies, Schulze et al. do find some reasons for optimism. In the five studies for which it was tested strategic bias was not evident. The evidence on instrument and information bias was limited (only two studies tested for all forms) and its presence was detected in one study but not the other. Perhaps most heartening was that the values derived via contingent valuation were not dissimilar to values obtained from property value, hedonic studies of wage rates, and travel-cost techniques.

What about the usefulness of contingent valuation techniques to evaluate government programs to reduce environmental risk? The two forms of bias of particular relevance to such an application would be informational and hypothetical; arising from the fact that individuals confronted with an existing or prospective source of contaminated drinking water have little information on the possible health consequences, their likelihood, and how effective private and public actions would be in reducing those risks. In attempting a survey, communities which have faced and responded to some initial diagnosis of groundwater contamination are likely to be better informed and able to relate to a more technical description of water quality with and without some project. Of the many questions that might be asked such individuals the following three would identify S, V and B as defined in the previous section: (a) "After being informed of the health risk from contaminated drinking water, what actions (if any) did you or your family take?" (b) "The government plans to remove all wastes from the site thought responsible for groundwater contamination. Toxic concentrations are expected to decline to the following levels. (Interviewee is shown a table with current and anticipated concentrations after cleanup.) What would you be willing to pay for cleanup based on the above anticipated reduction in toxic concentrations?" (c) "If the anticipated toxic concentrations could be achieved would you continue to take any self-protective actions? If yes, please specify."

The response to question (a) would be a description of some self-protective action or actions and the cost of such actions could be obtained from the interviewee or estimated independently. The response to question (b) would be an option price statement of the (expected) value for certain reductions in the concentration of the relevant toxics. The response to question (c) would indicate what self-protective actions would be employed after the government's cleanup program and the cost of such actions could also be estimated. Where self-protective actions require installation, maintenance, and possibly replacement, the present values of the actions described in responses (a) and (c) (ie a_1^o and a_1^g respectively) would have to be estimated. Thus, questions (a)-(c), or similar questions would provide estimates of c_1^o, V and c_1^g and in turn allow a calculation of S and B.

V. Conclusions and Caveats

The conclusions of this paper might be summarized in the following points.

1. Previous analyses of the value of reducing the probability of an

adverse state assume that the individual can reallocate wealth, W_s, through perfect insurance or contingent claims markets. Such markets do not exist for individuals confronted with risks to health from environmental hazards such as toxic waste sites.

2. A more realistic model might view the individual facing a fixed W_s but with the option of taking self-protective actions which, along with government action, may modify the subjective probability of ill-health. The value of government action in such a world is an option price; that is, a payment which equates expected utility with government action to the individual's expected utility without government action.

3. Option price in this case will be the sum of cost savings and the benefit of a reduction in the probability of the adverse state. The value of government actions to reduce risk will depend on the individual's set of self-protective actions (ie, how efficient the individual is in reducing risk).

4. Nonmarket evaluation techniques, now referred to as contingent valuation techniques, would allow one, in theory, to identify option price, V, cost savings, S, and the benefit of risk (probability) reduction, B.

The above conclusions, particularly the last two points, need to be interpreted with care. While self-protective actions are obviously available and exercised by individuals facing toxic waste hazards, they can also purchase insurance. The model of Section III was based on finite choice sets for the individual and government. From an initial situation which assumes a toxic waste or environmental hazard, the benefit of a government program reflects, in one sense, the inefficient allocation of risk imposed by the finite set of self-protective actions (Zeckhauser 1969). Thus the value of the government program may change if set A is modified and new self-protective actions are introduced.

While contingent valuation techniques would seem applicable to evaluate programs to reduce environmental risk and thus to evaluate overall program expenditures (is $1.6 billion enough?) the option price which would be estimated for an individual would be limited by the individual's ability-to-pay. Presumably $W_s - c_1^q - V > 0$. Thus such an evaluation, if used to rank sites for a priority of cleanup, would likely reflect the wealth of individuals adjacent to a site, with wealthier individuals willing and able to pay more. Similar equity considerations have arisen in the evaluation of air and water pollution programs where low income inner-city families are thought to bear a disproportionate cost of air pollution, while at the same time indicating a low willingness (ability) to pay.

The potential bias resulting from inadequate information and the hypothetical nature of contingent valuations techniques seems particularly troublesome in the context of evaluating toxic waste programs. When public health experts are hard-pressed to define the possible consequences and likelihoods it is heroic to assume that individuals and families actually faced with these risks would be in a position to know all the private actions open to them, much less the effectiveness of one or more government programs. Should the economist pack-up and go home? I think not. Rather, the economist is like the ringmaster of a small circus that has fallen on hard times. Contingent valuation is a clumsy, awkward elephant. But, it seems to be the only elephant we've got.

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