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Overview

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Overview

INTRODUCTION

The character and substance of environmental policymaking has changed over the past decade. With increased efforts in management of atmospheric and waterborne residuals has come a concomitant enhanced understanding of these environmental problems and a recognition of new ones. These new environmental issues raise significant challenges for both research and policy design.

Three aspects of these developments are addressed by the papers in this symposium issue.[1] The first of these arises from the selection of policy instruments for realizing environmental goals. One topic receiving increased attention from those interested in regulatory reform is the prospects for using decentralized markets (for pollution-related rights) as an alternative to existing regulatory programs that have been based largely on command-and-control policies. Economists are now accumulating experience with the practical issues arising from implementation of these reforms, and two of the papers in the first section consider aspects of this experience.

Our second topical area constitutes a reflection on the implications of Marshall's discussion of the essential ingredients of the demand for environmental quality. That is, while we teach those in our economics principles classes that demand implies want *plus* ability-to-pay, this concept has not been fully appreciated in the setting of our environmental goals. The decade of the seventies clearly evidenced the "want" dimension of demand through consistent expressions of public concern with improving environmental quality. However, with recent trends in fiscal austerity and unemployment, the ability-to-pay ingredient of effective demand has drawn increased recognition. Indeed, there is now much greater acceptance of the fact that enhancements to environmental quality are not free. Like other marketed goods and services, they involve real

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1. The majority of these papers were presented at the annual meetings of the American Economics Association and the Association of Enviromental and Resource Economists held in New York City, December 28–30, 1982. The authors gratefully acknowledge comments from those who formally discussed these papers.

costs that can have direct—through higher taxes—and indirect—with higher product prices—effects on households. Thus, environmental policy must become more discriminating—recognizing that choices are inevitable. Efficient use of scarce resources will require weighing the benefits associated with regulations as well as their costs.

The last area of discussion arises from the growing concern with issues related to environmental risks. These risks are the probabilities that an individual (or society as a whole) will experience some detrimental effect as an external consequence of particular production and consumption decisions. As Page has observed, environmental risks often involve effects that are not well understood.[2] The probabilities involved may be difficult to appraise on an objective basis. They are generally small. However, the implications of the detrimental outcome at risk may be catastrophic. Consequently, environmental risks pose especially difficult policy problems. The current debates as to the "appropriate" policies for managing the disposal of toxic materials and controlling the emissions of fluorocarbons[3] provide examples of these risks.

The papers in Section A of this symposium issue consider: (1) the new environmental policy issues of this decade; and (2) problems associated with the use of decentralized markets as the institutional framework for addressing such issues. The papers in Section B focus on the complex issues associated with measuring the benefits of environmental regulations. That is, they analyze methods available for measuring the benefits (including both the user and nonuser components) arising from improvements in environmental quality. Section C's papers are organized to consider specific problems that arise in connection with environmental risks, including: how models of individual behavior can be adapted to adequately address individual behavior in the presence of these risks; measuring individuals' willingness to pay for policies to limit environmental risks; and appraising modifications to the conventional practice of benefit-cost analysis.

A. Environmental Management: The Issues

All five papers in this section highlight elements of the political process in environmental policy analysis. That is, they provide the reader a better appreciation for the constrained role of economic analysis in policy design and evaluation. Legal constraints, together with conflicting ideologies of those involved in influencing decisions, make the political framework where decisions are made truly "second-best." Interactions between law,

2. Page, *A Generic View of Toxic Chemicals and Similar Risks*, 7 ECOLOGY L.Q. 207 (1978).

3. Fluorocarbons are a problem because they can accumulate as stock pollutants in the earth's upper atmosphere, affecting both the global climate and exposure to ultra-violet radiation.

politics, and economics lie at the center of the process by which building codes related to wind and earthquake destruction are formulated, as discussed in the paper by Hageman. These interactions are brought into clear perspective in Buc and Haymore's review of the process by which EPA has attempted to regulate the disposal, by incineration, of hazardous wastes. The central issue stressed in both of these papers is that, in considering regulations whose purpose is to protect public health and safety (through controlling the level and mix of environmental risks), debate as to "appropriate" regulatory forms becomes obscured. Regulatory means and ends become confused when uncertainty exists as to the nature and magnitude of the risks involved. Lack of credible information exacerbates the difficulties of deriving consensus on policies that assure that "acceptable" risk levels will not be exceeded.

Ostro and Anderson's presentation of the problem of benefits assessment for air quality standards also illustrates the influence that the bureaucratic politics of a particular decision has over the use of economic analysis. More specifically, these authors ask whether benefits analysis can be used in the design and evaluation of air quality standards. And if economic analysis is not used, then what will be the analytical framework? (We will return to this theme on a conceptual level with Runge's paper in Section C, which considers the relationship between benefit-cost analysis and risk assessment). Ostro and Anderson present credible evidence that analytically useful methods (and associated results) exist for appraising air quality effects. Nonetheless, to date these methods have not been used directly by EPA in its policy decisions on standards. It is somewhat ironic that a Presidential Order dealing with regulatory impact analysis (Executive Order 12,291) may in the final analysis be instrumental in requiring EPA to look at benefit-cost comparisons of alternative environmental standards.

In looking at benefit-cost studies for primary air quality standards, the role of morbidity studies in benefits assessment has been stressed. Of particular interest is the morbidity study described in Ostro and Anderson's paper. It appears that the economic welfare implications of morbidity damages may substantially exceed the more extensively studied mortality effects. Plausible evidence on variations in work days lost or impairment of activity due to respiratory problems may be more acceptable for use in standard setting than the equivalent mortality relations. While the mortality models have had a major role in past benefit-cost analyses, they have also been criticized because of the problems of omitted or unmeasurable variables, and the potential these models have for confounding effects arising from the need to use proxy measures for potentially important influences to health. Nonetheless, the fate of these morbidity studies (as potential influences to policy design) is up to a scientific panel

(i.e., the Clean Air Scientific Advisory Committee) which has the role of reviewing studies before they are used in EPA policy determinations. As might be expected, a tug-of-war exists in the appraisal of what can and what cannot be used to define benefits. From the standpoint of the economists involved, the morbidity study discussed by Ostro and Anderson represents potential for reconciliation between what are scientifically acceptable results for standard setting and the empirical results of the economists' morbidity dose-response studies.

In the remaining two papers of Section A, emphasis is given more specifically to the potential, but unused, role of the market for environmental management. The notable phenomenon—described in both the Shapiro and Warhit paper on chlorofluorocarbons and the Nelson and Bieniewicz paper on coal—is the hostility that greets the idea that greater reliance on market processes might usefully resolve a problem. Chlorofluorocarbon production permits provide a clear example of a marketable commodity. However, auctioning is precluded by law. Analysis of the administrative options for allocating permits made it evident that large rents attend any distribution of the permits. By contrast, a command-and-control approach to regulation, while it may involve the distribution of equal amounts of rent, serves to obscure the exact nature of that distribution.

Bieniewicz and Nelson also provide detailed analysis of the debate between those who would rely on market mechanisms and those who would retain the command-and-control approach to how much federal coal is leased (as well as when and where the leases are offered). It must be acknowledged that the law seriously distorts the federal government's coal leasing program by imposing an unreasonably short diligence limit of ten years on the lessee. Thus, a lease is not a right to mine but an option to mine which cannot be exercised unless, within a very short time after securing the lease, the mining company secures a contract to sell the coal. In addition to ideology and the law, a third factor must be taken into account in understanding the problem of leasing coal—the distribution of property rights. Although federal coal is ostensibly owned by the government, the property rights are actually held by the states. By law, states receive the largest share of the bonus and royalties. While environmentalists and bureaucrats also come in for a share of the property rights, it is the lesser share. Solutions to the problem of leasing federal coal that do not recognize constraints imposed by property rights, ideologies, and legal statutes are likely to be inefficient. Based on Nelson and Bieniewicz's appraisal, it would seem that market approaches have made as much headway as could be expected in the coal program.

B. Valuing Environmental Assets

In this section of the symposium, attention is focused on problems of valuing environmental assets. To illustrate some of the difficulties posed by valuing such assets, consider the following hypothetical example. Assume that it is possible to construct a dam across the lower gorge of the Grand Canyon. Such a project would create a reservoir with its associated "flat-water" recreation and would provide a hydro-electric power facility. However, the project would also flood this scenic wonder and, over a century or two, fill the chasm with silt. In evaluating the net benefits of this project we must ask how one would attempt to value the permanent loss of the Grand Canyon.

The traditional approach would likely be to apply the Hotelling-Clawson-Knetsch travel cost methodology.[4] Brown and Mendelsohn's paper describes the travel cost framework and explains the stringent theoretical assumptions it requires to overcome the paucity of data that are generally available for recreation models. While these models likely provide "order of magnitude" estimates of individuals' willingness to pay for a site's services (i.e., user values), as Brown and Mendelsohn acknowledge, most existing studies have failed to gauge the accuracy of the estimates they provide or to evaluate their sensitivity to underlying assumptions.

Returning to the example of the Grand Canyon, even if the travel cost approach could be applied without difficulty (and there is ample reason to believe that the underlying assumptions would be more limiting for this unique environmental asset than for a recreational facility with a more regional market), this approach measures only the user values of current visitors. Clearly, a preserved Grand Canyon may generate other values as well. Two types of nonuser benefits have been identified. One is option value, first identified by Weisbrod, which recognizes that consumers who have not currently and may never visit the Grand Canyon would be willing to pay to preserve the option of possible future use.[5] A second type of nonuser benefit is an existence value. This value arises because consumers might be willing to pay to preserve the Grand Canyon simply to know that it still exists in a natural state.[6]

Option value has generally been explained as the result of risk aversion—that is, an individual would pay more for guaranteed access to a site than his (or her) expected consumer surplus from future use. Two

4. M. CLAWSON & J. KNETSCH, ECONOMICS OF OUTDOOR RECREATION (1966).

5. Weisbrod, *Collective-Consumption Services of Individual Consumption Goods*, 78 Q.J. ECON. 471 (1964).

6. Krutilla, *Conservation Reconsidered*, 57 AM. ECON. REV. 777 (1967).

motives may be embedded in existence values. Consumers may simply feel themselves harmed if they discover that the Grand Canyon is lost as a natural wonder. Alternatively, current consumers may feel an obligation to preserve the Grand Canyon for future generations. This latter value has sometimes been termed bequest value.

The only technique now available for measuring nonuser values is the survey approach, in which consumers are asked to place a value on the preservation of an environmental asset. The survey approach has in fact been applied to the problem of valuing preservation of the Grand Canyon: Schulze, et al. have found that with respect to Canyon preservation, nonuser values may be several orders of magnitude larger than user value.[7]

Two of the papers in this section deal with the difficulties of applying the survey approach. The first, by Bishop, Heberlein and Kealy, offers a somewhat critical appraisal of survey techniques for estimating individuals' valuation of environmental resources. The second, by Randall, Hoehn and Brookshire, is more optimistic. What is remarkable about these two papers is the degree of convergence in their final conclusions. One can comfortably conclude after reading both papers that surveys do not produce "noise" in valuing environmental assets, but neither are they highly accurate. Value estimates from carefully designed surveys are likely to be accurate to within an order of magnitude. For example, one can use the survey method to determine if a consumer values preservation of the Grand Canyon at one dollar rather than $10 or $100 per month; but not if that value is three dollars versus seven dollars per month. Unfortunately we do not have the information necessary to fully appraise the accuracy of estimates derived from the travel cost framework. In some cases, such as the Grand Canyon, where the site is a unique natural environment, the assumptions of the model will clearly be subject to question. In others, the assumptions are more likely to hold and we can expect correspondingly better benefit estimates.

It should also be acknowledged that the accuracy of the survey approach seems related to apsects of the technique which can be evaluated in advance. If the environmental asset involved can be precisely described to respondents, then changes in the framing of the survey (that is, in the manner in which questions are asked) seem to have limited influence on dollar responses. However, if uncertainty surrounds the environmental asset, either informally due to poor survey design or formally due to the nature of the problem (for example, how much is it worth to consumers to contain toxic wastes given that we are uncertain as to the effects of exposure), then changes in framing of questions seem to alter the surveyed individuals' responses. Perhaps subjective probabilities are easily shifted

7. Schulze & Brookshire, *The Economic Benefits of Preserving Visibility in the National Parklands of the Southwest*, 23 NAT. RES. J. 149 (1983).

by framing. In any case, special care needs to be taken when uncertainty enters the analysis.

Estimating the components of nonuser values (especially option value) will require a better understanding of the ways individuals respond to uncertainty and of the plausibility of economic models of this behavior. Graham's paper begins the process of considering this issue by discussing the constituent elements in the theoretical basis for measuring option value.

C. Valuing Environmental Risk

The final group of papers in this symposium issue consider different aspects of the treatment of risk in benefit-cost analysis involving environmental resources. Before discussing those papers, however, it is important to acknowledge that the term risk can be confusing.[8] For our purposes, risk will be considered as an individual's likelihood of experiencing one or more adverse events. The three papers in this section discuss how applied welfare economics can (or must) be adapted to reflect the implications of risk for efficient resource allocation decisions.

We can organize the discussion in these papers by considering three general questions:

(1) Are the types of risks associated with environmental policy-making likely to affect the usefulness of conventional economic models of individual behavior in the presence of risk? And if not, in what ways must the models be altered to more adequately deal with these types of risk?

(2) Can these risks be treated as analogous to a commodity, in the sense that individuals will reveal, through their behavior, their willingness to pay for changes in the magnitude of the risks they experience?

(3) How do legislative mandates for the treatment of risks arising from use of environmental resources relate to criteria for efficient allocation of resources in the presence of these risks?

The first of these questions is considered directly in the Weinstein-Quinn paper and indirectly by Burness, et al. Weinstein and Quinn provide an excellent precis of the criticisms (based on experimental evidence) of economists' models of individual decision-making under uncertainty.[9] These economic models have been based on the state-preference descrip-

8. For a more detailed discussion of the features of environmental risks, *see* Page, *supra* note 2, at 208–12.

9. There are generally two approaches to modeling economic behavior under uncertainty. The first is the state-preference approach. It involves re-defining the objects of consumption as commodities contingent on a state of nature and using the von Neumann/Morgenstern expected utility framework (*see* note 10, *infra*) to describe individual choices. The second treats the statistical parameters of the probability distributions of income levels as the objects of choice. This approach has had its greatest applications in the theory of finance. For a review of the first approach, *see* Hirshleifer & Riley, *The Analytics of Uncertainty and Information: An Expository Survey*, 17 J. ECON. LIT. 1, 1375 (1979).

tion of individual choice in the presence of uncertainty, and have largely accepted the expected utility framework of von Neumann and Morgenstern (VNM).[10]

We can summarize many of the criticisms of these models with a simple description of the von Neumann/Morgenstern objective function. Assume each individual is confronted with choosing from among a set of actions (a = 1, 2, ..., k). Each action provides an uncertain set of outcomes, Y^a, that can arise in N possible states of the world (i.e., Y_i^a take on values Y_1^a, Y_2^a, ..., Y_N^a). The individual knows (or somehow assesses) the prior probabilities of these outcomes *for each action* and selects an action to maximize the value of his or her expected utility. An individual's utility function is assumed to be a function of income. The shape of this utility function is generally used to characterize the individual's attitude toward risk. Thus, for this simple decision problem the individual is viewed as selecting an "a" to maximize equation (1), with p_i^a (i = 1, 2, ..., N) designating his probabilities of the N states for each action (a = 1, 2, ..., k).[11]

$$(1) \qquad EU^a = \sum_{i=1}^{N} P_i^a \, U(Y_i^a)$$

The experimental work summarized in Weinstein and Quinn can be viewed as questioning this framework in three ways:

(a) is the optimization framework reasonable?

(b) do individuals perceive risks in ways that are consistent with the axioms governing the definition of probabilities?

(c) is an individual's preference function independent of the context or state under which consumption takes place?

The first of these is perhaps the most obvious. Some psychologists have argued that this formulation of the consumer decision process is simply incorrect because an individual's behavior does not conform to optimizing principles and therefore his decisions in an experimental setting cannot be explained by such principles.

The two remaining avenues of criticisms seem to call for specific amendments to the VNM objective function. Under the first of these, critics of the simple VNM framework have argued that individuals seek to maximize a function resembling (1). However, they suggest that the p_i^a's should be replaced by a function $P_i^a(.)$. Indeed, Kahneman and

10. J. VON NEUMANN & O. MORGENSTERN, THE THEORY OF GAMES AND ECONOMIC BEHAVIOR (2d ed. 1947).

11. This model can be structured in more detailed form by assuming each individual can purchase contingent claims. In this case the form of the budget constraint will affect the set of feasible responses to maximize expected utility.

Tversky's[12] prospect theory can be viewed as adopting this approach, with a specific set of proposed determinants to include the $P_i^a(.)$ functions. Under this view individuals do not act *as if* they had probabilities (as conventionally defined) weighing their respective valuations of the outcomes. Rather, they are assumed to "edit" the p_i^a's depending on a number of factors such as the values of the Y_i^a's, the values of other p_i^a's (i.e., within a given action) and even the values of p_i's for other actions.

The last criticism focuses on the nature of the utility function U(.), and maintains it is not invariant with respect to states of the world. Thus, this approach would replace the utility function used to value outcomes with one that was dependent on the states. Scholars concerned with the state-dependent approach ask why context matters.

While the experimental literature and the associated inconsistencies with expected utility theory seem to imply that observed decisions can be explained equally well by either of the two suggested amendments, it is important to note that the first type of amendment does not provide a complete behavioral model. One need only ask why individuals alter known probabilities. These models should not be confused with Bayesian analysis of individual behavior. The reasons for differences do not stem from individuals systematically updating their prior beliefs based on their experiences. Rather, this first type of amendment involves suggestions as to how individuals deal with probabilities. For example, one such suggestion indicates that there is an "editing" process which each individual undertakes to transform specified probabilities into the perceived weights for an objective function resembling an expected utility function. This approach *accounts* for the "shortfalls" of the expected utility framework with the experiments designed to test its assumptions—it does not *explain* those shortfalls.

The second approach—which would employ state dependent utility function—is more consistent with the evolution of economic models of behavior. It amends our description of individual preferences and explains observed outcomes as reflecting this more complex preference structure. However, given our understanding of individual decision-making under conditions of risk, we cannot be too sanguine or self-satisfied with this escape from the inconsistencies found in the experimental evidence. State-dependent utility functions are as much a reflection of our ignorance of how individuals value goods and services as they are an explanation of behavior with predictive potential. Weinstein and Quinn's proposal to recognize the role of blame for incorrect decisions, and credit for correct

12. Kahneman & Tversky, *Prospect Theory: An Analysis of Decision Under Risk*, 47 ECONOMETRICA 263-92 (1979).

decisions, can be interpreted as an attempt to understand one source of state dependency in individual utility functions.

How does the Weinstein/Quinn assessment of limitations to economic models for health-risk analysis relate to environmental policymaking? The answer is direct. Increases in health risks experienced by individuals are important aspects of the damages associated with environmental pollution. Economic analysis of the implications of alternative ambient air quality standards have attempted to appraise the nature of these risks and to value them. Clearly, the limitations to models of economic behavior figure prominently in any appraisal of these values. Air pollution is, of course, not the only area where health risks are important considerations. Most environmental risks (under Page's definition) would involve significant health risks. Certainly a dominant reason for the recent concern over hazardous waste management has been fear of adverse health effects.

The second paper in this section, by Burness et al., deals specifically with the hazardous waste policy area, and with practical problems in valuing policy-induced changes in risk of detrimental effects due to exposure to hazardous substances. Often the mechanisms giving rise to the risks do not permit the magnitude of these risks to be estimated with any degree of resolution. Some cases would be more aptly described as involving uncertainty in Knight's terms,[13] rather than measurable risk. In such cases how should a policymaker proceed? Of course, one obvious response might be that the best *action is inaction:* simply acquire information inasmuch as it has an enormous marginal value under these circumstances. Unfortunately, for some problems—such as hazardous waste management—the decision to withhold regulatory action until information is available will *not* be inaction in the sense implied above. Rather, it merely assures that the activities leading to the potential for these risks will proceed as if motivated by private incentives alone.

When there is uncertainty as to the nature of environmental risk, the following policy dilemma arises. First, society may postpone actions (such as the imposition of regulations) until more information is available; regulation costs are thereby avoided but threats to health and safety may increase while society waits for more information. Secondly, society may take immediate action (regulate), despite uncertainties as to the "need" for action; of course, later information may show that such action, and its associated costs, was unnecessary. Surely this dilemma is among the most vexing environmental policy issues. How in these circumstances does the policymaker respond to consumer sovereignty and move toward efficient resource allocation decisions?

Burness and his co-authors argue that we should explain the policy

13. F. H. KNIGHT, RISK, UNCERTAINTY AND PROFIT (1921).

dilemma to households and ask them to bid for a policy that would regulate (in this case) hazardous wastes. This process avoids the valuation of changes in risk and thereby seemingly avoids appraising the nature of that risk. It is ingenious but, unfortunately, it does not avoid the influences of the risk. We must expect that individuals' valuation of the policies will reflect their individual perceptions of these risks along with their *a priori* beliefs regarding the likely effectiveness of the policies themselves.

Finally, the last paper in this section asks how one can view the disparate guidance offered by legislative mandates and efficiency criteria in treating risk at the policy level. Runge argues that several of our programs for environmental regulation constrain the ways in which efficiency objectives can be met. More specifically, such legislation provides that policy actions should not allow the risks imposed on citizens to exceed some norm, regardless of the discounted net benefits they provide. Along these lines, Runge offers an interpretation of the potential relationship between legislative requirements that policies be designed to eliminate risks and criteria for the design of efficient regulation. Of course, what this suggested relationship serves to identify is that there can be efficiency losses associated with realizing this constraint.

Clearly, the next step in this process of understanding constraints on the application of efficiency guidelines for certain policy decisions will be explicit recognition that risk must be reflected in the definition of an efficient decision rule—that is, in how we measure the benefits and the costs and in how we select a discount rate—and therefore efficiency goals and legislative mandates for keeping risk below threshold levels may not be as disparate as they might seem at first. In Runge's framework the shadow price of adjusting policies to meet a risk threshold may well be inconsequential. Regardless of the outcome, by posing the problem in these terms, Runge has focused our discussion on the potential for incompatible goals.

These three papers serve to highlight some important aspects of the tasks of modeling, measurement, and policy design in the presence of risk. All of these aspects require further research. To specify the criteria for efficient resource allocation decisions in the presence of risk we must have a behavioral framework that describes how individuals respond to (and therefore value) changes in risk. The framework must be credible in the sense that it can withstand empirical testing. The analysis in these papers has suggested that the expected utility framework, in its simplest form, may not meet these requirements. Equally important for some applications, the risks of interest may be difficult to define and measure. Yet the nature of the risk may require some form of policy intervention before measurement is possible. It is not clear in these cases how efficient resource allocation decisions are to be prescribed. Efficiency implies that

resources will be allocated to their highest valued uses. Those values in our economic system reflect consumer sovereignty. Yet where information is often so incomplete as to be effectively nonexistent and decisions are required, how can the policymaker effectively reflect the consumer's interests? More generally, we might ask what is the relationship between the social attitude toward environmental risks and the individual's? Social goals may not mirror individual attitudes. Questions of modeling, measurement, and policy design in the presence of risk are challenging in their own right, and their importance to environmental policy-making is likely to grow.