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Long-Term Environmental Risks

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The most dramatic recent development in social risk policies has been increased international attention to global environmental issues. These problems are fundamental in nature, as they address the overall character of the earth's climate as well as the degree to which the earth's atmosphere will shield us from ultraviolet rays. There is also a substantial time dimension to these problems. Current decisions influence outcomes far into the future. Moreover, policy outcomes will be the result of a sequence of decisions made in the coming decades.

The first global environmental issue to receive prominent attention was that of ozone depletion. The increase in ozone-depleting emissions from economic activities that, for example, involve the use of chlorofluorocarbons, has led to measurable decreases in the earth's ozone layer. The economic costs of such depletion of ozone will include adverse health effects, such as skin cancer, as well as adverse effects on agriculture. The 1985 Vienna Convention marked the initial international effort to address the ozone depletion problem. In 1987, the Montreal Protocol established an international commitment to reduce the use of chlorofluorocarbons, such as those used in refrigerators and air conditioners.

Even more prominent has been the increased international attention to the problems of global warming. In 1990 there was an international meeting at the White House Conference on Scientific and Economic Research on the Environment to address the appropriate response to the increased warming that many scientists predict will take place over the next decades. The uncertainties involved are substantial. Scientific evidence is imprecise. The exact timing of the increased warming is unclear, as is the extent and geographical distribution of the warming. Moreover, there is substantial uncertainty with respect to individual responses to the change in the climate as well as the effect of these responses on economic welfare and social policy.

In recognition of the increased prominence of these issues, the *Journal of Risk and Uncertainty* has organized this symposium on long-term environmental risks. The articles included in this volume emphasize three aspects of the environmental risk problem. The first consists of an analysis of how we respond to long-term environmental risks. In particular, do individuals make sensible decisions when faced with risks of a long-term nature, and are these decisions qualitatively different from their response to more immediate risks.

These articles also address a second aspect of the long-term environmental risk problem pertaining to policies that can be used to reduce the global warming problem. The

chief new class of policies that has received substantial prominence in the United States has been a greater reliance on markets for pollution rights.

The final aspect of this long-term environmental risk problem that the articles will address pertains to the discounting of deferred risks associated with these policies. In particular, how should we weight the payoffs that extend far into the future?

The article by Baruch Fischhoff, "Understanding Long-Term Environmental Risks" begins the symposium. Fischhoff's main concern is with how individuals conceptualize long-term environmental risks and how we can promote better understanding of these risks. These concerns are important for ascertaining how society will respond to these risks as well as what political pressures will be exerted on the policies intended to address the environmental problems.

Fischhoff begins with an assessment of the obstacles to learning about long-term risks. For example, experience may play a limited role if events occur infrequently or have never been observed at all. In undertaking his analysis, he draws on patterns that have been exhibited in a variety of contexts, such as perceptions of the risk of AIDS.

Fischhoff couples his somewhat pessimistic diagnosis of individuals' perceptional performance with suggestions pertaining to how we can enable people to better understand long-term risks. Fostering risk communication in this manner is essential if society is to establish an appropriate course of action to address long-term hazards. Moreover, many of the responses that ultimately will be taken necessarily will involve individual action and not simply political efforts.

The second article in this symposium, by Jin Tan Liu and V. Kerry Smith, "Risk Communication and Attitude Change: Taiwan's National Debate over Nuclear Power" also draws upon evidence from other contexts in analyzing individuals' responses to long-term risks. In this case, the article focuses on a specific policy context, that of the public's understanding of nuclear power. Their study draws on a natural experiment that took place in Taiwan, where there was a national debate over nuclear power early in 1989. The authors rely on evidence gathered pertaining to risk perceptions before and after the debate.

The Liu and Smith study suggests that the debate had little effect on the attitudes toward nuclear power. The debate did not have the reassuring effect on the citizenry that was the original intention of the National Power Company. Moreover, those who learned about the debate through television became less enthusiastic about nuclear power after witnessing it.

The next article by Robert Hahn and Roger Noll, "Environmental Markets in the Year 2000," turns to the task of designing an appropriate governmental policy to address long-term environmental risks. The chief distinctive aspect of the environmental policy mix advocated by President Bush is the proposed greater reliance on market alternatives. In particular, he proposed further examination of the desirability of marketable emissions permits whereby firms would be permitted to engage in market trades for rights to pollution.

This concept is now new. Economists have discussed it for over two decades, and the U.S. Environmental Protection Agency has long utilized market-based systems such as this, although on a very limited basis.

Hahn and Noll explore the conditions for operating such a market effectively. In particular, ideally we would want the market to be efficient and trading to take place without substantial costs. Hahn and Noll couple this assessment with an evaluation of the lead trading program administered by the U.S. Environmental Protection Agency, which they conclude has had beneficial effects in terms of cost savings as well as apparent success in meeting the environmental objectives.

Hahn and Noll also examine the new classes of uncertainties created by the introduction of a new policy mechanism such as this. In particular, how will such trading systems respond to new hazards that we learn about in the future? In addition, what will be the response of firms to such a shift in the policy regime? As the authors indicate, there are substantial costs that will be involved in the transition period as well as a series of complex distributional effects at stake.

The next set of three articles address the appropriate discounting of long-term environmental risks. Because of the substantial time lags involved before the benefits of these environmental policies will be reaped, the choice of the discount rate often dictates much of the menu of viable policy alternatives. U.S. Environmental Protection Agency officials often suggest the use of a discount rate of zero percent, whereas the regulatory oversight officials at the Office of Management and Budget insist on a much higher rate. These debates are of more than academic consequence since a shift in the discount rate of one or two percent—much less than the 10 percent difference that often is the subject of the debates—will often have profound effects.

The first article addressing the discount rate issue is that of Maureen Cropper and Paul Portney, "Discounting and the Evaluation of Life-Saving Programs." The focus of their article is on conceptualizing discounting issues pertaining to death risks. Cropper and Portney are also cognizant of the need for empirical analysis, and they report on some of the empirical assessments that have been performed.

Although there is a substantial literature conceptualizing discounting problems, few of these assessments have addressed the key elements that enter when considering environmental risks. In particular, in the case of risks of death there is both an intra-generational discounting issue as well as an inter-generational discounting issue. If, for example, we are discounting future benefits to ourselves that will occur after some lag, the discount rate conceivably might be different than the rate we would apply to discounting risks to the lives of future generations. Appropriate and efficient resolution of this discounting problem is essential since these future generations are not yet born and cannot carry out any bargains to enable us to undertake sound decisions.

The major impetus to the Cropper and Portney analysis is the role of the substantial latency periods involved for many environmental risks. After constructing a model to reflect these deferred risks, they examine the variation in the willingness to pay for risk reductions with individual age as well as a variety of other aspects regarding social discounting. One of their principal results is that from the standpoint of cost-effectiveness analysis one should equalize the present value of future benefits that will be derived from each additional dollar that is expended.

The next article by Michael J. Moore and W. Kip Viscusi, "Models for Estimating Discount Rates for Long-Term Health Risks Using Labor Market Data," reports on

empirical evidence pertaining to implicit discount rates revealed by workers through their risk-taking decisions. Their main focus is on the wage-death risk tradeoff within the context of a lifetime decision problem under uncertainty.

Because of the potential sensitivity of the results to the estimation approach used, this article reports on the empirical estimates obtained using six different empirical models, three of which are newly developed for this article. The models differ in terms of the manner in which the worker's decision problem is structured or in which the model is implemented empirically. For example, some but not all of the models are based on an explicit Markov decision problem that must be solved by the worker incurring death risks, where the functional form derived from this analysis is used in the estimation process.

The discount rate estimates ranged from one percent to fourteen percent. The confidence intervals for these estimates generally overlap with observed rates of interest consumers incurred for the time periods associated with the data. Thus, these estimates are consistent with the practice of employing the same discount rates used in weighting financial rewards over time to evaluate death risks as well.

While often instructive, market-based data provides little evidence regarding the weights we place on future generations, particularly if individuals recognize the free-rider problem involved in any action they take which may affect future generations. There are other limits to the range of questions that can be addressed with market data, which has led analysts to utilize experimental data.

An article by John Horowitz and Richard Carson, "Discounting Statistical Lives," utilizes experimental evidence in an effort to fill such gaps. In particular, their study involves a series of policy choice scenarios that were presented to undergraduate student subjects in an effort to ascertain their preferences with respect to policy alternatives with widely different patterns of impacts. Their study is intended in part to explore the usefulness of the experimental approach to discounting issues.

The survey instrument focused on attitudes toward the risk of fatal airplane crashes that could be addressed by a variety of policy alternatives, such as a new radar system. The main issue pertained to how soon the airlines should be required to install a radar system or whether instead airplane safety itself should be improved directly.

The findings Horowitz and Carson reached were generally in line with discount rates revealed in the market place for financial rewards. Moreover, they suggest that their experimental method offers considerable flexibility for addressing a wide variety of other patterns of environmental risks that cannot be readily handled with existing data.

Although none of these articles completely resolves any of the issues pertaining to long-term environmental risks, they do make substantial headway both in conceptualizing many of the important problems that arise as well as in deriving empirical guidance for making sounder decisions. Because of the inherently long-range character of the problems that this research is addressing, it is likely that there will be continued examination and refinement of our understanding of these issues for many years to come.