

# HUMAN AND TECHNOLOGICAL RESPONSE TO ENDOGENOUS ENVIRONMENTAL RISK

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## Contents

1. Introduction: Choice Matters
2. Who Likes Separability?
3. Modeling Endogenous Risk
4. Risk Valuation
5. Broadening the Vision: Human Capital Formation
6. Broadening the Vision: Endogenous Risk Preferences
7. Conclusion

Acknowledgements

Glossary

Bibliography

Biographical Sketches

## Summary

People have choices when confronting an environmental risk—they can choose to reduce risk privately or collectively, either by altering the odds that bad events happen, or by reducing the severity of those bad events that do happen. Incorporating these choices into risk assessment and reduction strategies has ramifications for sustainable development policy. This endogenous risk perspective can increase the precision of risk assessment, cause the benefits of risk reduction to be more accurately estimated, and temper the behavior of those exposed to risk who spend excessively on self-protection. Failure to acknowledge the influence that individual choice has on environmental risk will result in excessive economic expenditure at no gain in environmental quality. The key is to create incentives that reward those who attempt to unify risk assessment and management into an integrated system.

## 1. Introduction: Choice Matters

Risk, its consequences, aversion to it, and its control, are key factors in policy decisions about managing human and technological resources for sustainable development. People create risk to wealth and health through their choices and technologies, but they also react to control the risk they create. New options or technologies are found or created to reduce risk or simply transfer the risk to another time or place. Investment is made in human capital and physical capital to build tools to address risk. These choices and investments work to link economic systems and environmental systems. The choices made affect nature just as nature affects the choices. And while this seems obvious, yet it is commonly oversimplified by both the ordinary person in the street and the natural scientist at work, who generally think of the disciplines as separate, and

assume that combining economics with natural science would not alter the core of either.

Current environmental policy makes that same separability assumption. In keeping with this, the sanctified risk assessment-risk management bifurcation has profoundly affected how natural scientists describe environmental hazard risk, and how economists, among others, evaluate environmental policy. Economists have facilitated this view by accepting that it is the job of natural science to assess risks and of economists to step in afterwards and manage them. This split has led to another assumption: that risks to environmental and natural resources are exogenous, in other words, outside of any person's control.

But it is argued in this article that this view is misguided. All economic choices undeniably occur in specific environments and have consequences for nature; nature does not happen in lonely isolation. Relative prices and relative wealth in a region, therefore, need to be included in any explanation of how nature works. Attempts by natural scientists to keep nature and economics separate perpetuate an omitted variable bias in their conclusions: a key link is missing, and the completeness of their science is compromised. This is like a baker leaving the eggs out of a cake. Although a cake of sorts may nevertheless be produced, that cake could be much better.

The simplest answer to the question, "Why should human resources and technology choices driven by economic circumstances matter to a natural scientist interested in sustainable development?" is that people like nature. Because they like it, they make adjustments in their behavior that affect the way it works. Nature is akin to a factory that makes services people enjoy. Its ability to produce those services depends on the relative wealth of people around it. Here is a model of choice under scarcity, which is the very heart of the science of economics. Nature is a perfect example of a scarce audience which both affects and is affected by the human drama.

The commonly accepted world-view says that humans are a blight on nature, but that simple statement does not address the fact that humans recognize themselves as such and attempt corrective measures. They create a series of adaptive and mitigative actions and reactions, and a feedback loop to nature is born. Intuition and everyday evidence show indisputably that human activity helps to determine natural events.

Risks to well-being from climate change and from a species losses currently dominate discussions of sustainable development. They are not exempted from this principle. Conservation biologists, for example, usually maintain that establishing the threshold of species endangerment is strictly a biological question. They say that it is determined by the present sizes, trends, and distributions of populations, and by their likely interactions with the random forces of nature. These events are said not to affect the productivity of human reactions to these risks. But this perspective is too narrow. Species survival also depends on economic parameters, such as the relative prices of sites and site users and community wealth: the rich have more resources to set aside quality habitat. Assessing the risk to species and determining the probability of survival are economic as well as biological problems. Hence, risk is endogenous: subject to determination from within the system.

The endogenous risk perspective is thus properly skeptical about the popular risk assessment-management bifurcation. The perfectly reasonable principle that nature could exist autonomously need not mean that it does exist autonomously. The separability which the bifurcation implies ought to be systematically demonstrated rather than routinely invoked. In the absence of unequivocal evidence that separability applies, proper risk assessment incorporates parameters from both the environmental and economic systems—humans affect nature, nature affects humans. This theory is positive, not normative. The choices to invest in human or technological resources therefore have a role in both the science and the management of sustainability.

## **2. Who Likes Separability?**

There is, nevertheless, a practical contribution of the separability assumption to the assessment of environmental problems which has helped to sustain it. Three evaluation criteria for this contribution are described here—a list which is neither exhaustive nor mutually exclusive: tractability, specificity and relevancy.

Excluding economic variables undoubtedly makes life easier for the natural scientist interested in sustainable development—the scientist is not then required to leave the boundaries of natural science. But this exclusion requires that the scientist looks only at a piece of the picture. The typical cause and effect, or dose-response model, used in natural sciences provides predictions that are independent of possible choices of the subject; the model says everyone is likely to have the same risk. In so doing, it describes just part of the dose that affects the response. The ability to ex post adapt to conditions or to ex ante mitigate them is ignored, even though this ability can affect actual outcomes profoundly. For example, a person potentially exposed to toxic fumes may choose to buy a gas mask—if it is affordable—and thereby reduce mitigate personal risk. If that person can afford a better mask than the neighbor, the risk reduction is relatively more. Such examples of mitigation abound. People move or reduce physical activity when air pollution becomes intolerable. They buy bottled water if they suspect that alternative supplies are polluted; they apply sunscreen to protect their skin from UV radiation. Each choice alters the risk environmental hazards pose to a person's health and welfare. How people invest resources to increase the odds that good things happen depends on both their attitudes towards risk and the technology available to them to reduce risk. Yet separability presumes that the researcher knows what evidence any decision agent used.

If more tractability were the only goal, the separability restriction has clearly been successful historically. But the cost is that the restriction may be too thin to organize the wide range of behaviors in the face of risks from environmental hazards that is often witnessed. For instance, while implicitly invoking the separability restriction, researchers often regard the increasing marginal benefits of risk reduction that they observe as being a lapse from rational behavior. But without that restriction, it is possible to show that endogenous risk is fully consistent with increasing—as well as decreasing—marginal benefits to environmental hazard risk reduction. If a general theory explains purported anomalies, and if the anomalies appear only when the general theory is burdened with particular additional restrictions, the seeming anomalies must

be due to the restrictions rather than the general theory—a classic case of the tail wagging the dog.

Of course, grasping the structure of cause and effect, including the relative primacy of multiple causes, is the goal of all scientific inquiry. Those who can get a handle on complex issues and find solutions are rewarded. Specificity is sought. But if economic factors are eliminated to achieve those sharp results, the good has been thrown out with the bad.

Specificity can be attained either by repeated empirical observations under controlled conditions or by axiomatic methods. Economists use such axioms to move from the soft idea of preferences to the precise notion of a utility function: the utility maximization paradigm singularly dominates economic analysis. But in the application of the biological sciences to environmental phenomena, no single paradigm exists. The objective selected for the same biological system, for the same problem, will differ from one biological expert to another. Even within their discipline, reputable ecologists explicitly state that ecology lacks broad generalizations useful for making environmental management decisions at the site-specific or field level.

The separability assumption has another problematic consequence in environmental research when the connections between cause and effect are complex. If the connections are simple, or if the transaction costs of science are trivial, the separability assumption is probably moot, since hazard risk is then exogenous. But the complexity of connections between cause and effect causes errors in scientific assessment, and there are conflicts over proper scientific tests and protocols in which the economist can get tangled up—if operating under the separability restriction, which requires the true cause be identified. Confronting the real complexity, and assuming nonseparability, removes the economist from those conflicts by at least one step, so that it is then not necessary to settle on a particular scientific parable, but it will be possible to get around in the world.

Whatever arguments can be made for separability in terms of specificity and tractability, the real cost of the assumption comes in terms of relevance: that is, the relevant applications of economics to environmental problems. By allowing the separability restriction, economists are voluntarily relegating their expertise to a passive role that is subordinate to that of natural scientists in environmental research and policy deliberations. Natural scientists have no incentive to account for the impact of human behavioral responses to risk on natural phenomena if economists allow them to follow the separability assumption to the conclusion that risk must be exogenous.

Noneconomists can interpret separability as saying that nature sets the pace and that people react and respond, but do not alter its everyday workings. This perspective places economics on the sidelines during the creation of environmental policy. Rather than opting for great tractability and the appearance (if not the reality) of specificity, economists will have more opportunities to participate in environmental research and policy if they make the least arbitrary and most coherent set of modeling choices. With but few rather exceptional cases, assuming nonseparability represents this set for endogenous risk and the natural environment. The approach may make economists more

like the aforementioned ecologists who lack broad generalizations, but they will be less arbitrary and will remain coherent.

Some observers have contended that economics is irrelevant to environmental knowledge because it has avoiding the complexities of sciences such as psychology and biology. With all due respect, this argument has it backwards. The reality is that economists have hobbled themselves by not convincing those foundation sciences to connect mind to matter by including economic parameters in their core frameworks. Economists have a responsibility to correct this omission by asking that separability be justified whenever invoked. Otherwise, they are complicit in their own marginalization, appearing to confirm the predisposition of non-economists to treat natural systems and economic systems as independent.

Why should natural sciences go through all the trouble to explicitly incorporate this link? The estimated value of collective environmental protection is too low otherwise, and benefit estimates in cost-benefit analysis are biased downward. Consider, for instance, sexual behavior and the risk of AIDS. Standard epidemiological practices treat an individual's decisions concerning frequency of contact and number of partners to be independent of the prevalence of the disease.

However, if one assumes that individuals chooses their own risks based on the odds faced and what they can do to reduce these odds, economic circumstances can identified under which these private actions will actually affect the spread of AIDS in the population. In another example the gains from reducing the risk of lead poisoning in US children doubles when the parents' decisions to reduce exposures and body burdens are accounted for. Finally, analyses of environmental health also require a more sophisticated treatment of economic influences. A good example is the nine-fold increase in calculated benefits of a well-functioning wetland acre (average) following from the inclusion of the behavioral interactions of economies and ecosystems.

Thus the separability of natural events and human adaptation is not just one more in a long line of trade-offs between tractability and completeness; the separability question runs deeper. Its invocation removes economists' obligation—and opportunity—to help to define the environmental thresholds of human and ecosystem health that underpin policy. Separability threatens to reduce the relevance of economists, and ensures that they have no seat at the table where most environmental research is designed. Economists will be provided a secure seat only when the prevalence of endogenous risk in environmental problems is widely granted.

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**Thomas D. Crocker** is the J. E. Warren Distinguished Professor of Energy and Environment in the Department of Economics and Finance at the University of Wyoming. He earlier held faculty appointments at the University of Wisconsin and the University of California, and a visiting appointment at the Pennsylvania State University. He was also the founding director of the School and the Institute of Environment and Natural Resources at the University of Wyoming. Among his nearly 150 refereed publications are the original proposal for an analysis of tradable emission permits, the first empirical application of the Coase theorem, and two of the initial treatments in environmental settings of the principal agent problem. He also contributed to the initial development of environmental valuation techniques, especially the hedonic technique. Recently his research has focused mostly on the ways in which ecological and economic systems mediate each other's responses to change, endogenous risk, and the impact of environmental change upon human capital formation. His current work focuses upon the determinants of internal household environment and their effects upon child development.

**Jason Shogren** is the Stroock Distinguished Professor of Natural Resource Conservation and Management, and is a professor of economics at the University of Wyoming. His research focuses on the behavioral underpinnings of private choice and public policy, especially for environmental and natural resources. Before returning to his *alma mater*, he taught at Iowa State and Yale. In 1997, Shogren served as the senior economist for environmental and natural resource policy on the Council of Economic Advisers in the White House. Currently, he serves on the Environmental Economics Science Advisory Board for the US Environmental Protection Agency, and the Intergovernmental Panel on Climate Change. Governor Geringer recently appointed him to Wyoming's Environmental Quality Council. Shogren is also on the advisory committee for *Enlibra*, the Western Governors Association's new doctrine for environmental management. He was an associate editor of the *Journal of Environmental Economics and Management*, and the *American Journal of Agricultural Economics*. Recent publications include *Environmental Economics* (Oxford University Press, 1997), *Private Property and the Endangered Species Act* (University of Texas Press, 1999); *Endangered Species Protection in the United States* (Cambridge University Press, 2001); and papers on risk, conflict, cooperation, valuation, environmental policy, and experimental economics. The American Association of Agricultural Economics selected his essay with J. Tschirhart on the Endangered Species Act at 25 as the Best Choices Article for 1999.