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TAKING EXTERNALITIES SERIOUSLY: AN ECONOMIC PERSPECTIVE ON THE PRECAUTIONARY PRINCIPLE

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"When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."

—Wingspread Statement on the Precautionary Principle
January 1998

The Precautionary Principle directly addresses the need to act in the presence of real scientific uncertainty, when large "what ifs" cast a shadow across the promised benefits of an activity. It calls for preventative action to protect public health and the environment even in the absence of concretely established cause and effect relationships.

The growing support for a precautionary approach to environmental decisionmaking reflects a sense that current methodologies of risk assessment and their associated policy recommendations have failed to provide an acceptable level of protection against catastrophic and potentially irreversible environmental damage.

The Precautionary Principle appears in several international environmental accords and treaties and enjoys wide support in Europe. In the United States, some national policies—such as those concerning drugs, food additives, and workplace safety—already use a precautionary approach. Support for making the Precautionary Principle a central element of local and national environmental policy is growing rapidly. Not surprisingly, so is the opposition from those who benefit from the current decisionmaking rules, which typically require strict proof of harm before taking action and give the benefit of the doubt to potentially hazardous products and chemicals.

Far from damaging the economy, careful analysis demonstrates that a precautionary approach can actually enhance economic efficiency, raise living standards, and lead to environmentally benign technological innovation.

One of the key criticisms of the Precautionary Principle is that it will result in costly, stultifying regulations that decrease economic efficiency and lower living standards. Of course, economic considerations are just one among many of the inputs into good environmental decisions, but it is nonetheless crucial to directly confront this issue. Far from damaging the economy, careful analysis demonstrates that a precautionary approach can actually enhance economic efficiency, raise living standards, and lead to environmentally benign technological innovation.

EXTERNALITIES, EFFICIENCY, AND ECONOMICS

The economic analysis of environmental issues starts with the concept of an "externality" or a cost or benefit that is not correctly accounted for in market transactions. Negative externalities occur when an individual or an organization takes an action that benefits themselves while forcing some of the costs on to other people. One person's decision to drive to work may save them time, but it also increases air pollution and highway congestion for everyone else. A new manufacturing plant might be a profitable venture for investors, but it also releases irritating particles and noxious gasses into the air, causing health problems and lowering local property values.

Externalities can be positive as well. For example, a yard landscaped with trees and flowers provides a scenic view for the neighbors and shade for passing pedestrians. Similarly, the benefits of a forest reserve in the Amazon that fixes large quantities of carbon dioxide and preserves species diversity accrue to people all over the globe, but the costs of maintaining the reserve are paid locally.

One of the key beliefs underlying economic analysis is that "incentives matter." Unfortunately, when it comes to the creation of negative externalities, all the incentives run in the wrong direction. Rational self-interested individuals and profit-maximizing firms try to shift as many costs as possible to other parties while retaining as many benefits as possible for their exclusive use. That's why economists expect negative externalities to outnumber positive ones.

In a market economy, prices both communicate information and provide incentives. High prices are a powerful incentive to economize on scarce resources; low prices encourage use of relatively abundant resources. The claim that market outcomes are efficient rests on the ability of prices to signal the most valued

use of a resource and to promote the search for cheaper alternatives. Consequently, when prices fail to reflect all the costs of an action markets outcomes are no longer efficient. Externalities, by definition, arise when some costs or benefits are "external" to the market and are not accounted for in the price of an action, are a form of market failure and a source of economic inefficiency.

Overall economic well-being increases when all the costs of an activity are accounted for—allowing individuals and organizations to offload costs onto third parties distorts incentives and decreases economic efficiency. A market economy that permits individuals to use shared resources for private gain will overexploit those resources and suffer from inefficiently high levels of pollution. A market economy that permits individuals to offload costs in the form of higher exposure to risk will fail to provide the right incentives for true economic progress and create inefficiently large risks of ecological catastrophe. Left to themselves, free markets generate inefficient outcomes plagued by excessive pollution and environmental degradation. Effective environmental policies enhance economic efficiency by eliminating externalities.

Exposure to risk and uncertainty is an increasingly important type of negative externality, especially when an action increases the risks of environmental and public health catastrophes.

EXTERNALITIES AND RISK

The existence of externalities, and the associated inefficiencies, have been one of the primary arguments for government intervention in a market economy since the time of Adam Smith. However, the negative externalities associated with industrial production have changed over time. No longer are we concerned primarily with visible smokestack pollution. These days, costly side effects are often subtle and hard to observe, with years or decades passing before they are fully documented and understood. At the same time, the harm done to the environment and human health can be extremely long lasting or irreversible. There is a growing body of scientific literature that documents adverse effects of chemicals at levels that just a few years ago were below our detection threshold.

Unfortunately, while scientific understanding of the adverse effects of the by-products of industrial production continues to evolve, massive amounts of pollutants in the form of carbon dioxide and monoxide, noxious gasses, heavy metals, and man-made chemicals are released into the environment every day.

The repercussions of these actions extend far beyond the local environment and the current generation. Scientific evidence now confirms the decades-old prediction that increased levels of carbon dioxide and other greenhouse gases in the atmosphere have lead to global warming. These effects will persist for years even if industrialized nations make dramatic reductions in the release of greenhouse gasses immediately. Toxic chemicals known as persistent organic pollutants (POPs) do not degrade after being released into the environment but instead persist and accumulate in the bodies of living creatures. The negative externalities associated with current and past industrial practices impact every human being alive today and will continue to impose costs for generations to come.

RISK = COST

What are the risks of dumping large quantities of man-made chemicals, many of which are not found in nature and have not been adequately tested, into the environment? What are the risks of dramatically changing the composition of the earth's atmosphere and disrupting the mechanisms that govern the earth's climate? What are the risks of altering the genetic makeup of biological organisms and then releasing these organisms into the environment, potentially interbreeding with or outcompeting native species? What are the risks of developing new technologies that can literally take on a life of their own without forecasting or understanding the range of impacts they may have on ecosystems and human societies?

We don't know, and can't know, exactly what these risks are. But what we do know is that people don't like risk. Consequently, the costs of existing practices and new technologies extend far beyond the tangible consequences of toxic pollution and global climate change. Exposure to risk and uncertainty is an increasingly important type of negative externality, especially when an action increases the risks of environmental and public health catastrophes.

Empirical evidence for aversion to risk abounds. People are willing to pay to avoid risk, and demand higher compensation when exposed to it. Consumers spend billions of dollars annually on insurance against a wide variety of bad outcomes, many of which have only a small probability of occurring. The average return on risky assets is much higher than the return on risk-free assets, indicating a premium for exposure to financial risk. In other words, risk is a cost. And when it's involuntarily imposed on third parties, risk becomes an economically inefficient negative externality.

The risks created by individual decisions to utilize a toxic chemical or develop a new technology become costs borne by other people. Consequently, it's not enough to claim that the benefits of a proposed activity exceed the costs based on the most likely or mean outcome. This simplistic "cost-benefit" calculation ignores the full costs created by risky activities and allows risk-loving individuals or corporations to impose externalities on third parties. In a risk-averse world, the entire range of possible outcomes and our collective aversion to risk should be considered in the decision making process.

COMPLEXITY & CHAOS

How can we anticipate the full range of consequences and the associated risks of an activity or new technology? Ironically, it seems that the more we learn about the dynamics of complex

systems the more we realize how difficult it is to understand and predict them. For example, we know that El Niño and its associated weather patterns result from a reversal of the normal flow of ocean currents from the eastern to the western Pacific, which is in turn caused by small variations in ocean temperatures. We can't predict the factors that tip the system over the critical threshold, but nonetheless El Niño transforms wind and precipitation patterns worldwide, often with devastating effects on local populations.

Recent advances in the study of chaos and complexity highlight our limited knowledge of human-ecosystem interactions. Lake ecosystems can experience sudden and potentially irreversible regime changes in response to small increases in the level of phosphorus contamination. Similarly, if higher than average rainfall has already saturated the soil, a small amount of additional rainfall can lead to a dramatic increase in runoff and flooding. Biological models of predator-prey interactions and of the spread of epidemics provide some of the classic demonstrations of chaotic behavior with sensitive dependence on small changes in initial states. Conventional techniques of cost-benefit analysis and risk management seriously underestimate the costs of negative externalities in these situations.

New technologies that alter the process of biological reproduction, such as genetic engineering or cloning, or which themselves have the capacity for self-replication, such as evolvable nanotechnology and robotics, generate even more profound uncertainties and risks. Computer scientist Bill Joy argues that the risks of these new technologies vastly exceed those of previous human inventions, including nuclear armaments. A bomb, Joy notes, can explode only once, but uncontrolled self-replication of genetically-modified organisms or molecular scale nanobots could overwhelm the existing ecosystem and create as yet unimagined ecological catastrophes.

The damage caused by the introduction of destructive non-native species into local ecosystems (for example, Gypsy moths in the eastern United States, zebra mussels in the Great Lakes or rabbits in Australia) gives a small preview of the costly consequences of self-replication run amok. Yet we blindly introduce new organisms and deploy new technologies capable of fundamentally altering the dynamics of systems that we scarcely understand in the first place.

THE PRECAUTIONARY PRINCIPLE

In addition to clearly identifying the nature of externalities, economic reasoning can also inform the choice of strategies for dealing with them. Again, many of the key insights follow directly from the economist's motto: "Incentives matter." Economic analysis offers two important lessons to consider in developing a successful environmental policy: 1) externalities are a source of economic inefficiency; 2) understanding and modifying incentives are keys to preventing them.

The Precautionary Principle represents a proactive, forward-looking approach to environmental decision making. It promotes economic efficiency by identifying negative externalities before they occur, by eliminating both externalities and the incentives to create them in the first place, and by shaping the development of new technologies that make better use of the available resources and have fewer hidden costs. One common statement of the principle is: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically." (Wingspread Statement on the Precautionary Principle, January 1998)

At its most basic level, the precautionary principle mandates preventative action to protect human health and the environment even in the absence of scientific certainty. In addition, it encompasses several related concepts that address negative externalities and adverse private incentives. The precautionary principle requires proponents of an action to consider its potential externalities before proceeding. For example, a precautionary approach to man-made chemicals would require that their health and safety effects be investigated before they are produced and released into the environment rather than assuming that they are harmless until proven otherwise. The precautionary principle also mandates serious consideration of all the alternatives to a proposed activity, including the alternative of no action, and calls for democratic representation of all affected parties in the decisionmaking process.

Traditional command-and-control environmental regulations require specific pollution control technologies, leaving little reason to look for cheaper, better ways of solving problems. Incentive-based environmental regulations, on the other hand, set maximal allowable levels of pollutants without specifying the exact means used to achieve the goals. In practice, however, both these approaches tend to be reactive rather than pro-active.

Current environmental policies don't provide incentives to prevent externalities before they occur. Instead, they wait for strict proof of harm and only attempt remediation after the damage has been done. The release of tens of thousands of untested man-made chemicals into the environment typifies this "wait and see" attitude. Needless to say, reactive polices are particularly unsuited to dealing with complex uncertain externalities like global warming or with externalities that are subtle and hard to detect.

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Incorporating the precautionary principle into environmental policy will help counteract the existing incentives to create and disguise negative externalities in several important ways:

- By requiring that potential side effects be considered before an action is taken, the precautionary principle helps to identify and prevent negative externalities before they occur. This process of disclosure will make it more difficult to withhold information or hide the existence of the externality.

- By placing the burden of proof on proponents of an activity and requiring preventative action even in the absence of scientific certainty, the precautionary principle reduces the incentives to strategically create spurious uncertainty.

- By considering alternative technologies and means of achieving the desired outcome, the precautionary principle helps society identify the alternative that generates the fewest negative externalities.

Precaution as a tool for guiding environmental policy decisions has its foundations in the German concept of *Vorsorge,* meaning precaution, or more generally, foresight or forethought. The shift to prevention embodied in the precautionary principle is a necessary and timely response to the increasingly severe environmental hazards that we collectively face. When the effects of industrial production were confined to a local area and a short time horizon, a "wait and see" attitude towards externalities might have been justified.

Now, however, we are now learning some painful and costly lessons about the long term and unanticipated consequences of pollution. Lead, mercury, cadmium, dioxins, furans, PCBs and a witches' brew of other heavy metals and persistent organic pollutants continue to bio-accumulate long after being released into the environment. Exposure *in utero* (or at other key points in development) to extremely small amounts of these substances can have subtle functional effects on the nervous, immune and endocrine systems—this is one of the legacies that we are leaving to future generations.

From the mounting evidence of global warming and climatic instability, to the emerging connection between environmental exposure to toxic chemicals and the skyrocketing incidence of learning disabilities, immune system disorders and certain types of cancer, to the specter of a plague of uncontrollable self-replicating organisms overwhelming the ecosystem, it's clear that the potential and actual damage to the global environment has increased in both scope and scale.

Like a court of law in which guilt must be established "beyond a reasonable doubt," the court of scientific opinion maintains a very high standard of evidence before declaring a cause and effect relationship between two events. However, relying on a similar standard of proof when it comes to anticipating and preventing negative externalities doesn't make much sense from a public policy point of view. In a risky and risk-averse world, prevention is more likely to benefit social welfare than costly remediation afterwards. The precautionary principle takes the available scientific evidence as an input into the decision process rather than letting an external standard of "scientific certainty" dictate environmental policies.

Our understanding of complex nonlinear systems is in its infancy, or at best, in its awkward and unpredictable adolescence. Even under ideal circumstances identifying a nonlinear relationship is more difficult and requires more data than identifying a linear one. In practice, we must also contend with limited knowledge of the underlying system dynamics, the possibility of multiple equilibria, feedback effects between seemingly disparate system elements, and a lack of data based on controlled experiments. The evidence required to fully establish a cause and effect relationship may not be available until well after the damage has occurred, especially for large scale systemic events like global climatic change. Applying strict standards of proof of harm in this context will bias the decision making process against taking action to prevent negative externalities.

Critics argue that precaution will damage the economy and reduce innovation. Careful application of economic reasoning shows just the opposite: the precautionary principle helps to address the well known economic problem of negative externalities by addressing the problem at its root rather than attempting to remediate the situation after the damage has already been done.