

BEYOND THE PRECAUTIONARY PRINCIPLE

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The precautionary principle has been highly influential in legal systems all over the world. In its strongest and most distinctive forms, the principle imposes a burden of proof on those who create potential risks, and it requires regulation of activities even if it cannot be shown that those activities are likely to produce significant harms. Taken in this strong form, the precautionary principle should be rejected, not because it leads in bad directions, but because it leads in no direction at all. The principle is literally paralyzing—prohibiting inaction, stringent regulation, and everything in between. The reason is that in the relevant cases, every step, including inaction, creates a risk to health, the environment, or both. This point raises a further puzzle: Why is the precautionary principle widely seen to offer real guidance? The answer lies in identifiable cognitive mechanisms emphasized by behavioral economists. In many cases, loss aversion plays a large role, accompanied by a false belief that nature is benign. Sometimes the availability heuristic is at work. Probability neglect plays a role as well. Most often, those who use the precautionary principle fall victim to what might be called “system neglect,” which involves a failure to attend to the systemic effects of regulation. Examples are given from numerous areas, involving arsenic regulation, global warming and the Kyoto Protocol, nuclear power, pharmaceutical regulation, cloning, pesticide regulation, and genetic modification of food. The salutary moral and political goals of the precautionary principle should be promoted through other, more effective methods.

INTRODUCTION

All over the world, there is increasing interest in a simple idea for the regulation of risk: In case of doubt, follow the *precautionary principle*.¹ Avoid steps that will create a risk of harm. Until safety is estab-

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¹ For general discussions of the precautionary principle, see INTERPRETING THE PRECAUTIONARY PRINCIPLE (Timothy O’Riordan & James Cameron eds., 1994); PROTECTING PUBLIC HEALTH & THE ENVIRONMENT: IMPLEMENTING THE

lished, be cautious; do not require unambiguous evidence. In a catchphrase: better safe than sorry. In ordinary life, pleas of this kind seem quite sensible, indeed a part of ordinary human rationality. People buy smoke alarms and insurance. They wear seat belts and motorcycle helmets, even if they are unlikely to be involved in an accident. Shouldn't the same approach be followed by rational regulators as well? Many people believe so.²

A. *Problems with Precautions*

I aim to challenge the precautionary principle here, not because it leads in bad directions, but because, read for all that it is worth, it leads in no direction at all. The principle threatens to be paralyzing, forbidding regulation, inaction, and every step in between.³ To explain this problem very briefly, the precautionary principle provides help only if we blind ourselves to many aspects of risk-related situations and focus on a narrow subset of what is at stake.⁴ A significant part of my discussion will be devoted to showing why this is so. I will also urge that the precautionary principle gives the (false) appearance of being workable only because of identifiable cognitive mechanisms, which lead people to have a narrow rather than wide viewscreen. With that narrow viewscreen, it is possible to ignore, or to neglect, some of the risks that are actually at stake. I emphasize that we have good reason to endorse the goals that motivate many people to endorse the precautionary principle. These goals include the importance of protecting health and the environment even from remote risks, the need to attend to unintended adverse effects of technological change, and the need to ensure that wealthy countries pay their fair share for environmental improvement and risk reduction. But

PRECAUTIONARY PRINCIPLE (Carolyn Raffensperger & Joel A. Tickner eds., 1999) [hereinafter IMPLEMENTING THE PRECAUTIONARY PRINCIPLE]. A valuable discussion of problems with the precautionary principle in Europe is Giandomenico Majone, *What Price Safety? The Precautionary Principle and Its Policy Implications*, 40 J. COMMON MKT. STUD. 89 (2002).

² See the account of widespread international support *infra* Part I.

³ For criticisms that also emphasize the range of risks at stake, see INDUR M. GOKLANY, *THE PRECAUTIONARY PRINCIPLE: A CRITICAL APPRAISAL OF ENVIRONMENTAL RISK ASSESSMENT* (2001); Jonathan B. Wiener, *Precaution in a Multirisk World*, in HUMAN AND ECOLOGICAL RISK ASSESSMENT 1509 (Dennis J. Paustenbach ed., 2002).

⁴ For a discussion of the possibly perverse effects of the precautionary principle, see Frank B. Cross, *Paradoxical Perils of the Precautionary Principle*, 53 WASH. & LEE L. REV. 851 (1996). I think that much of what Cross says is convincing, but my emphasis here is quite different; I stress the cognitive foundations of the principle and urge not that the principle leads in perverse directions, but that it offers no guidance at all.

the precautionary principle is a crude way of protecting these goals, which should be pursued directly. I do not attempt to develop any particular replacement for the precautionary principle, but I do argue on behalf of wide viewscreens in the regulation of risks.

In making these claims, I will be challenging an idea that is fast becoming a staple of regulatory policy.⁵ Indeed, it has been claimed that the precautionary principle has become, or at least is becoming, a binding part of customary international law.⁶ In the mid-1970s, German environmental policy was founded on the basis of *Vorsorgeprinzip*, a precursor of the precautionary principle.⁷ With respect to risks, German policy has been described as seeing “precaution” as a highly interventionist idea, one that embodies “a loose and open-ended interpretation of precaution.”⁸ In the United States, without using the term explicitly, Congress has built a notion of precaution into some important statutes, allowing or requiring regulation on the basis of conservative assumptions.⁹ The precautionary principle has played a

⁵ For helpful discussions of the evolution of the precautionary principle, see David Freestone & Ellen Hey, *Origins and Development of the Precautionary Principle*, in *THE PRECAUTIONARY PRINCIPLE AND INTERNATIONAL LAW: THE CHALLENGE OF IMPLEMENTATION 3* (Int'l Envtl. Law & Policy Series No. 31, David Freestone & Ellen Hey eds., 1996); Wiener, *supra* note 3.

⁶ See Owen McIntyre & Thomas Mosedale, *The Precautionary Principle as a Norm of Customary International Law*, 9 J. ENVTL. L. 221, 235 (1997) (“Opinion remains divided as to whether the precautionary principle may have crystallised into a binding norm of customary international law. However, the prevalence of the principle in recent environmental treaties, declarations and resolutions . . . suggests that it may indeed have attained this status.”). See generally ARIE TROUWBORST, *EVOLUTION AND STATUS OF THE PRECAUTIONARY PRINCIPLE IN INTERNATIONAL LAW* (Int'l Envtl. Law & Policy Series No. 62, 2002) (representing the precautionary principle as part of the basic foundation of international environmental law throughout the past decade).

⁷ Julian Morris, *Defining the Precautionary Principle*, in *RETHINKING RISK AND THE PRECAUTIONARY PRINCIPLE 1, 1* (Julian Morris ed., 2000).

⁸ Timothy O'Riordan & James Cameron, *The History and Contemporary Significance of the Precautionary Principle*, in *INTERPRETING THE PRECAUTIONARY PRINCIPLE*, *supra* note 1, at 12, 17.

⁹ See, e.g., Clean Air Act § 109, 42 U.S.C. § 7409(b)(1) (2000) (“National primary ambient air quality standards . . . shall be ambient air quality standards the attainment and maintenance of which in the judgment of the Administrator, . . . allowing an adequate margin of safety, are requisite to protect the public health.”); see also *Am. Trucking Ass'ns v. EPA*, 283 F.3d 355, 378 (D.C. Cir. 2002) (“EPA must err on the side of caution, just as it did here—setting the [air quality standards] at whatever level it deems necessary and sufficient to protect the public health with an adequate margin of safety . . .”); *Lead Indus. Ass'n v. EPA*, 647 F.2d 1130, 1155 (D.C. Cir. 1980) (“Congress directed the Administrator to err on the side of caution We see no reason why this court should . . . requir[e] the Administrator to show that there is a medical consensus that the effects on which the lead standards were based are ‘clearly harmful to health.’”).

significant role in international documents, to the point where it has become ubiquitous. Variations on the notion can be found in at least fourteen international documents.¹⁰ In 1982, the United Nations World Charter for Nature apparently gave the first international recognition to the principle, suggesting that when “potential adverse effects are not fully understood, the activities should not proceed.”¹¹ The 1992 *Rio Declaration on Environment and Development* asserts: “In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”¹²

The widely publicized *Wingspread Declaration*, from a meeting of environmentalists in 1998, goes further still: “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 established scientifically. In this context the proponent of the activity, rather than the public, should bear the burden of proof.”¹³

¹⁰ GOKLANY, *supra* note 3, at 3. Indeed, there appears to be a cascade effect here, leading to many casual uses of the precautionary principle, to the point where a failure to incorporate the principle would seem to be a radical statement. Simply because the precautionary principle has been used so often, those involved in international agreements are likely to believe that it is probably sensible to use it yet again. And because so many people identify the precautionary principle with a serious commitment to environmental protection, *see, e.g.*, Andrew Jordan & Timothy O’Riordan, *The Precautionary Principle in Contemporary Environmental Policy and Politics*, in IMPLEMENTING THE PRECAUTIONARY PRINCIPLE, *supra* note 1, at 15, 23 (“At [the precautionary principle’s] core lies the intuitively simple idea that decision makers should act in advance of scientific certainty to protect the environment (and with it, the well-being of future generations) from incurring harm.”), any nation that rejects the principle risks incurring international opprobrium. For a general treatment of informational cascades, in which decisions by others convey information about what it makes sense to do, *see* David Hirshleifer, *The Blind Leading the Blind: Social Influence, Fads, and Informational Cascades*, in THE NEW ECONOMICS OF HUMAN BEHAVIOR 188, 188-98 (Mariano Tommasi & Kathryn Ierulli eds., 1995); on reputational pressures, *see* TIMUR KURAN, PRIVATE TRUTHS, PUBLIC LIES: THE SOCIAL CONSEQUENCES OF PREFERENCE FALSIFICATION 26-30 (1995).

¹¹ *World Charter for Nature*, G.A. Res. 7, U.N. GAOR, 37th Sess., Annex, Agenda Item 21, at 5, U.N. Doc. A/RES/37/7 (1982).

¹² *Rio Declaration on Environment and Development*, U.N. Conference on Environment and Development, Annex I, princ. 15, U.N. Doc. A/Conf.151/5/Rev.1 (1992) [hereinafter *Rio Declaration*], reprinted in 31 I.L.M. 874, 879.

¹³ *Lessons from Wingspread*, in IMPLEMENTING THE PRECAUTIONARY PRINCIPLE, *supra* note 1, app. A, at 353-54 (quoting the *Wingspread Statement on the Precautionary Principle*); *see also* *To Foresee and to Forestall*, in IMPLEMENTING THE PRECAUTIONARY PRINCIPLE, *supra* note 1, at 1, 7-9 (discussing the history of the Wingspread Conference on Implementing the Precautionary Principle). The *Wingspread Declaration* was issued by a

The European Union treaty states that EU policy on the environment “shall be based on the precautionary principle.”¹⁴ In February 2000, the precautionary principle was explicitly adopted by the European Commission, together with implementing guidelines.¹⁵ Notwithstanding official American ambivalence about the principle,¹⁶ there are unmistakable echoes of the principle in American environmental law.¹⁷ The precautionary principle has received a high-profile endorsement in the *New York Times Magazine*, which listed the principle as one of the most important ideas of 2001.¹⁸

In many ways the precautionary principle seems quite sensible, even appealing.¹⁹ To justify regulation, a certainty of harm should not be required; a risk, even a low one, may well be enough. It makes sense to expend resources to prevent a small chance of disaster—consider the high costs, pecuniary and otherwise, that are spent to reduce the risk of terrorist attacks. On reasonable assumptions, these costs are worth incurring even if the probability of harm, in individual cases or even in the aggregate, is relatively low. The precautionary principle might well be seen as a plea for a kind of regulatory insurance. Certainly the principle might do some real-world good, spurring gov-

group of international scientists, government officials, lawyers, labor activists, and grass-roots environmental activists following a meeting at Wingspread in Racine, Wisconsin to discuss the precautionary principle. Peter Montague, *The Precautionary Principle*, RACHEL'S ENV'T & HEALTH WKLY., Feb. 19, 1998, at 1, 1, available at <http://www.monitor.net/rachel/r586.html>.

¹⁴ TREATY ESTABLISHING THE EUROPEAN COMMUNITY, Nov. 10, 1997, art. 174, O.J. (C 340) 3 (1997).

¹⁵ Press Release, European Commission, Commission Adopts Communication on Precautionary Principle (Feb. 2, 2000), http://europa.eu.int/comm/dgs/health_consumer/library/press/press38_en.html.

¹⁶ See Wiener, *supra* note 3, at 1510 (noting that although a “precautionary preference” is mentioned in some legislation, “the United States has not officially adopted the Precautionary Principle as a general basis for regulation”); John D. Graham, The Role of Precaution in Risk Assessment and Management: An American’s View, Remarks at the Conference on a Comparative Case Study Analysis of the Management of Risk in a Complex World (Jan. 11-12, 2002), at <http://www.useu.be/RiskManagement/Jan1102GrahamUSRiskManagementPrecPrin.html> (“[T]he U.S. government supports precautionary approaches to risk management but we do not recognize any universal precautionary principle. We consider it to be . . . mythical . . . like a unicorn.”).

¹⁷ See the reference to an “adequate margin of safety” in section 109 of the Clean Air Act, 42 U.S.C. § 7409(b)(1) (2000).

¹⁸ *The Year in Ideas: A to Z*, N.Y. TIMES, Dec. 9, 2001, § 6 (Magazine), at 92.

¹⁹ For a valuable and informative collection, see THE PRECAUTIONARY PRINCIPLE IN THE 20TH CENTURY (Poul Harremoës et al. eds., 2002). This volume provides a number of case studies in which government responded too slowly to real risks, including those associated with asbestos, DES, sulfur dioxide, and MTBE in gasoline.

ernments to attend to neglected problems. Nonetheless, I will be urging that the principle cannot be fully defended in these ways, simply because risks are on all sides of social situations. Any effort to be universally precautionary will be paralyzing, forbidding every imaginable step, including no step at all.

B. *Precautions and Rationality*

But if the precautionary principle, taken in a strong form, is unhelpful, in a way literally senseless, how can we account for its extraordinary influence, and indeed for the widespread belief that it can and should guide regulatory judgments? I have mentioned its possible pragmatic value. And undoubtedly the principle is invoked strategically by self-interested political actors; European farmers, for example, invoke the idea of precaution to stifle American competitors, who are far more likely to rely on genetically modified crops.²⁰ But apart from this point, I suggest that an understanding of human rationality and cognition provides five useful clues.

1. Loss Aversion

The precautionary principle often seems appealing because of loss aversion. The central point here is that people dislike losses far more than they like corresponding gains.²¹ The result is that out-of-pocket costs, or deterioration from the status quo, seem much worse than opportunity costs, or benefits lost as a result of continuing the status quo. In the context of risks, people tend to focus on the losses that are associated with some activity or hazard and to disregard the gains that might be associated with that activity or hazard. The precautionary principle often becomes operational only because of loss aversion, as people take precautions against potential losses from the status quo, but neglect potential benefits that would be unmistakable gains.

²⁰ See Timur Kuran & Cass R. Sunstein, *Availability Cascades and Risk Regulation*, 51 STAN. L. REV. 683, 745-46 (1999) (“In Britain, vandalism against genetic testing sites has become so common that the government is trying to conceal their locations. In sharp contrast, American consumers are for the time being fairly relaxed about genetic engineering, perhaps because most are unaware of how common this alteration procedure has become.”).

²¹ See Daniel Kahneman & Amos Tversky, *Prospect Theory: An Analysis of Decision Under Risk*, 47 ECONOMETRICA 263, 279 (1979) (“The aggravation that one experiences in losing a sum of money appears to be greater than the pleasure associated with gaining the same amount.” (citation omitted)), reprinted in CHOICES, VALUES, AND FRAMES 17, 33 (Daniel Kahneman & Amos Tversky eds., 2000).

A closely related point is that unfamiliar risks produce far more concern than familiar ones, even if the latter are statistically larger; and the precautionary principle, in practice, is much affected by this fact.

2. The Myth of a Benevolent Nature

Loss aversion is often accompanied by a mistaken belief that nature is essentially benign,²² leading people to think that safety and health are generally at risk only or mostly as a result of human intervention. A belief in the relative safety of nature and the relative risk of new technologies often informs the precautionary principle.

3. The Availability Heuristic

It is well known that people focus on some risks simply because they are cognitively “available,” whereas other risks are not.²³ When the precautionary principle seems to require stringent controls on one risk, even though other risks are in the vicinity, the availability heuristic is a common reason. And when the availability heuristic is at work, certain hazards will stand out, whether or not they are statistically large.²⁴ The hazards associated with heat waves, for example, receive little public attention, while the hazards associated with air travel are a significant source of public concern.²⁵ One reason for this is that the latter hazards come readily to mind.

²² See JAMES P. COLLMAN, *NATURALLY DANGEROUS* 29-33 (2001) (explaining that despite the popular misconception that what is natural is safe, natural substances can be dangerous to human health).

²³ See Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics and Biases*, 185 *SCIENCE* (n.s.) 1124, 1127 (1974) (“There are situations in which people assess the frequency of a class or the probability of an event by the ease with which instances or occurrences can be brought to mind.”), *reprinted in* *JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES* 3, 11 (Daniel Kahneman et al. eds., 1982).

²⁴ See Paul Slovic et al., *Cognitive Processes and Societal Risk Taking*, in *COGNITION AND SOCIAL BEHAVIOR* 165, 174-75 (John S. Carroll & John W. Payne eds., 1976) (stating that “[t]he most important public hazards are events with extremely low probabilities and extremely great consequences,” such as major floods, earthquakes, mudflows, and serious radiation release from a nuclear power reactor), *reprinted in* *PAUL SLOVIC, THE PERCEPTION OF RISK* 32, 41 (2000).

²⁵ See ERIC KLINENBERG, *HEAT WAVE: A SOCIAL AUTOPSY OF DISASTER IN CHICAGO* 10 (2002) (comparing coverage of the crash of TWA Flight 800 with the Chicago heat wave of 1995).

4. Probability Neglect

People are sometimes prone to neglect the probability that a bad outcome will occur; they focus instead on the outcome itself.²⁶ The precautionary principle often embodies a form of probability neglect. At least it does so when people invoke the principle to favor stringent controls on a low-probability risk, even though the consequence of those very controls is to give rise to new risks of equal or greater probability.²⁷

5. System Neglect

The precautionary principle often reflects a general neglect of the systemic effects of regulation.²⁸ When a single problem is placed in view, it can be difficult to see the full consequences of legal interventions. Sometimes the precautionary principle has the appearance of being workable only because a subset of the relevant effects are “on-screen”—and, as a result, there seems to be no need to take precautions against other possible adverse effects, also involving health and safety, that do not register. An important aspect of system neglect is *tradeoff neglect*, one source of the conflict between experts and ordinary people in thinking about risks.²⁹ When experts disagree with ordinary people about risks, it is sometimes because experts look at both the benefits and the harms associated with the relevant practice, whereas ordinary people are paying attention to the harms but not the benefits.³⁰ I suggest that the precautionary principle seems appealing, to ordinary people, in large part for the same reason.

²⁶ See Yuval Rottenstreich & Christopher K. Hsee, *Money, Kisses, and Electric Shocks: On the Affective Psychology of Risk*, 12 PSYCHOL. SCI. 185, 188 (2001) (describing an experiment in which participants framed their decisions around two possible outcomes—a painful electric shock or a monetary penalty in lieu of the shock—rather than the probability of each occurring).

²⁷ In some cases, this is a reasonable reading of the evidence governing genetically modified food. See ALAN MCHUGHEN, PANDORA’S PICNIC BASKET: THE POTENTIAL AND HAZARDS OF GENETICALLY MODIFIED FOODS 230-42 (2000) (noting that consumers who consume organic food in an attempt to avoid the perceived dangers of genetically modified food may be putting themselves at a greater risk).

²⁸ See DIETRICH DÖRNER, THE LOGIC OF FAILURE 1-47 (1996) (describing the characteristics of regulation that bring about a system’s failure).

²⁹ The conflict is treated in Paul Slovic, *Perception of Risk*, 236 SCIENCE (n.s.) 280 (1987), reprinted in SLOVIC, *supra* note 24, at 220.

³⁰ See HOWARD MARGOLIS, DEALING WITH RISK 99-119 (1996) (discussing the differences between expert and lay assessments of risk).

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One of my major goals is to show that the precautionary principle can be made workable only through routes of this kind. An understanding of behavioral economics simultaneously sheds light on the operation of the principle, explains its otherwise puzzling appeal, and suggests why it should be abandoned or at least substantially recast. Indeed, behavioral economics provides a better understanding of the uses and pitfalls of the old adage, “better safe than sorry,” which is subject to many of the same objections as the precautionary principle. I do not attempt to identify a competing principle for adoption by sensible regulators. But I do urge that such regulators should use a wide rather than narrow viewscreen—and that, as applied, the precautionary principle is defective precisely because it runs afoul of this idea. To be sure, many of those who endorse the principle seek to protect against neglect of the future, disregard of the interests of those suffering from the greatest deprivation, and impossible demands for unambiguous evidence from regulators. But as we shall see, the precautionary principle is a crude and sometimes perverse way of promoting these goals, which can be obtained through other, better routes. A major purpose of this Article is to suggest the need to use more direct, effective strategies to pursue the salutary goals of risk regulation.

This Article comes in four parts. Part I briefly traces the nature and the appeal of the precautionary principle. Part II explains why the principle is paralyzing, with particular reference to the issues raised by arsenic, global warming, nuclear power, and genetic engineering of food. Part III suggests that the apparent sense of the principle is best understood in light of the behavioral points just mentioned. Part IV is a brief conclusion, in the form of a plea for wider viewcreens.

I. THE PRECAUTIONARY PRINCIPLE: DEFINITION AND APPEAL

I have said that the precautionary principle enjoys widespread international support.³¹ But what does the principle mean or require? There are numerous definitions, and they are not compatible with one another.³² We can imagine a continuum of understandings. At

³¹ On this point, see sources cited *supra* note 6.

³² See Morris, *supra* note 7, at 1-19 (distinguishing the two broad classes of definitions of the precautionary principle: the strong precautionary principle and the weak

one extreme are weak versions to which no reasonable person could object; at the other extreme are strong versions that would appear to call for a fundamental rethinking of regulatory policy.

The most cautious and weak versions suggest, quite sensibly, that a lack of decisive evidence of harm should not be grounds for refusing to regulate. Regulation might be justified even if we cannot establish a definite connection between, for example, low-level exposures to certain carcinogens and adverse effects on human health. In particular, regulation might be urged, in such cases, if its costs are relatively low. Thus, the 1992 *Rio Declaration* sensibly states that “[w]here there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”³³ The Ministerial Declaration of the Second International Conference on the Protection of the North Sea, held in London in 1987, states in the same vein: “Accepting that in order to protect the North Sea from possibly damaging effects of the most dangerous substances, a precautionary approach is necessary which may require action to control inputs of such substances even before a causal link has been established by absolutely clear scientific evidence.”³⁴ Similarly, the United Nations Framework Convention on Climate Change offers cautious language:

Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing . . . [regulatory] measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost.³⁵

The *Wingspread Declaration* goes further: “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. In this context the proponent of an activity, rather than the public, should bear the burden of

precautionary principle); Wiener, *supra* note 3, at 1513 (recognizing that there is no single definition for the precautionary principle and that existing definitions are “varied” and “often vague”).

³³ *Rio Declaration*, *supra* note 12, at Annex I, princ. 15.

³⁴ Second International Conference on the Protection of the North Sea: Ministerial Declaration Calling for Reduction of Pollution, Nov. 25, 1987, art. VII, 27 I.L.M. 835, 838 (1988) (emphasis omitted).

³⁵ U.N. Framework Convention on Climate Change, May 9, 1992, art. 3, princ. 3, S. TREATY DOC. NO. 102-38, 1771 U.N.T.S. 108.

proof.”³⁶ The first sentence just quoted is a mildly more aggressive version of the statement from the *Rio Declaration*; it is more aggressive because it is not limited to threats of serious or irreversible damage. But in reversing the burden of proof, the second sentence goes further still.³⁷ Of course, everything depends on what those with the burden of proof must show in particular.

In Europe, the precautionary principle is sometimes understood in an even stronger way, suggesting that it is important to build “a margin of safety into all decision making.”³⁸ According to one definition, the precautionary principle means “that action should be taken to correct a problem as soon as there is evidence that harm may occur, not after the harm has already occurred.”³⁹ In a comparably strong version, it is said that

the precautionary principle mandates that when there is a risk of significant health or environmental damage to others or to future generations, and when there is scientific uncertainty as to the nature of that damage or the likelihood of the risk, then decisions should be made so as to prevent such activities from being conducted unless and until scientific evidence shows that the damage will not occur.⁴⁰

The Cartagena Protocol on Biosafety to the Convention on Biological Diversity, adopted in 2000, appears to adopt a strong version as well.⁴¹ The Final Declaration of the First European Seas at Risk Conference says that if “the ‘worst case scenario’ for a certain activity is serious

³⁶ IMPLEMENTING THE PRECAUTIONARY PRINCIPLE, *supra* note 1, at 353-54 (quoting the *Wingspread Statement on the Precautionary Principle*).

³⁷ See David W. Pearce, *The Preconditions for Achieving Consensus in the Context of Technological Risk*, in TECHNOLOGICAL RISK: ITS PERCEPTION AND HANDLING IN THE EUROPEAN COMMUNITY 57, 62 (Meinolf Dierkes et al. eds., 1980) (suggesting that the public be presented with “access to information or expertise” from both sides of the debate so that “[i]nquiry procedures . . . remain adversarial”); Wiener, *supra* note 3, at 1515-18 (recognizing some dangers of shifting the burden of proof, such as overregulation, but at the same time endorsing the idea since the proponent of the activity is best able to generate the information that will be used in making the decisions).

³⁸ Thomas Lundmark, *Principles and Instruments of German Environmental Law*, 4 J. ENVTL. L. & PRAC. 43, 44 (1997).

³⁹ Paul McFedries, *Precautionary Principle*, WORD SPY, Jan. 23, 2002, at <http://www.wordspy.com/words/precautionaryprinciple.asp>.

⁴⁰ *Capitol Hill Hearing Testimony Concerning the Cloning of Humans and Genetic Modifications Before the Subcomm. on Labor, Health and Human Serus., S. Appropriations Comm., 107th Cong. (2002)* (statement of Dr. Brent Blackwelder, President, Friends of the Earth), LEXIS, CNGTST File [hereinafter Statement of Dr. Brent Blackwelder].

⁴¹ See GOKLANY, *supra* note 3, at 6 (discussing the Convention’s application of the precautionary principle to biological diversity decision making).

enough then even a small amount of doubt as to the safety of that activity is sufficient to stop it taking place.”⁴²

Professor Richard Stewart usefully distinguishes among four different versions of the precautionary principle, capturing both weak and strong types:⁴³

1. *Nonpreclusion Precautionary Principle.* Regulation should not be precluded by the absence of scientific uncertainty about activities that pose a risk of substantial harm.

2. *Margin of Safety Precautionary Principle.* Regulation should include a margin of safety, limiting activities below the level at which adverse effects have not been found or predicted.

3. *Best Available Technology Precautionary Principle.* Best available technology requirements should be imposed on activities that pose an uncertain potential to create substantial harm, unless those in favor of those activities can show that they present no appreciable risk.

4. *Prohibitory Precautionary Principle.* Prohibitions should be imposed on activities that have an uncertain potential to impose substantial harm, unless those in favor of those activities can show that they present no appreciable risk.

This account shows that the precautionary principle might be described *both* in terms of the level of uncertainty that triggers a regulatory response *and* in terms of the tool that will be chosen in the face of uncertainty (as in the case of technological requirements or prohibitions). With an appreciation of this point, we can easily imagine many other variations on these themes. For example, an *Information Disclosure Precautionary Principle* might say that in the face of uncertainty, those who subject people to potential risks must disclose relevant information to those so subjected. The debate over labeling genetically modified organisms can be seen as a debate over this form of the precautionary principle.⁴⁴ An *Economic Incentive Precautionary Principle*

⁴² *Proceedings of the First European Seas at Risk Conference*, N. SEA MONITOR (Seas at Risk, Copenhagen, Den.), Apr. 1995, Annex I, at 60, quoted in Richard B. Stewart, *Environmental Regulatory Decision Making Under Uncertainty*, in 20 RESEARCH IN LAW AND ECONOMICS 71, 78 (Timothy Swanson ed., 2002).

⁴³ Stewart, *supra* note 42, at 76.

⁴⁴ See MCHUGHEN, *supra* note 27, at 201-29 (describing the problems associated with the current system of labeling genetically modified foods, such as the fact that it leads to indiscriminate, blanket labeling of all genetically modified foods, defeating its own purpose of informing consumers of the risks of the specific product). California's Proposition 65, codified in CAL. HEALTH & SAFETY CODE § 25249.6 (West 1999), requires disclosure of exposure to carcinogens and reproductive toxins and can be understood as reflecting an Information Disclosure Precautionary Principle. See ROBERT

might say that, in the face of doubt, economic incentives should be used to reduce potential risks. For every regulatory tool,⁴⁵ there is a corresponding precautionary principle, with possible matches or mismatches between the problem that calls for the precautions and the chosen tool.⁴⁶ The idea of “margin of safety” can itself be understood in multiple different ways, with a continuum from a small margin designed to counteract likely risks, to a large one designed to prevent worst cases. As we shall see, multiple margins of safety threaten to increase other social risks, as by leading people to switch to more dangerous products.

The official account in Europe is very much in favor of one or another version of the precautionary principle, with the European Commission having formally adopted it.⁴⁷ But European practice is far more complex, with the precautionary principle being invoked against some risks but not against others.⁴⁸ To take just one example, “Europe has been more precautionary about hormones in beef, while the US has been more precautionary about mad cow disease (BSE) in beef and blood donations.”⁴⁹ While European nations have taken a highly precautionary approach to genetically modified foods,⁵⁰ the United States has been especially willing to control the risks associated

PERCIVAL ET AL., ENVIRONMENTAL REGULATION: LAW, SCIENCE, AND POLICY 520-30 (3d ed. 2000) (describing Proposition 65 as a burden-shifting approach to the disclosure of information).

⁴⁵ For discussions of regulatory tools, see STEPHEN BREYER, REGULATION AND ITS REFORM 36-183 (1982); CASS R. SUNSTEIN, RISK AND REASON 251-88 (2002).

⁴⁶ On mismatch, see BREYER, *supra* note 45, at 191-96.

⁴⁷ Communication from the Commission on the Precautionary Principle, COM(00)1 final, available at http://europa.eu.int/comm/dgs/health_consumer/library/pub/pub07_en.pdf.

⁴⁸ On this complexity, see the illuminating discussion in Jonathan B. Wiener & Michael D. Rogers, *Comparing Precaution in the United States and Europe*, 5 J. RISK RES. 317 (2002).

⁴⁹ *Id.* at 323.

⁵⁰ See Tony Gilland, *Precaution, GM Crops and Farmland Birds*, in RETHINKING RISK AND THE PRECAUTIONARY PRINCIPLE, *supra* note 7, at 60, 60-63 (hypothesizing that the United Kingdom’s more cautious approach to genetically modified crops is due to the large percentage of total land that is farmed); see also David Vogel & Diahanna Lynch, Council on Foreign Relations, *The Regulation of GMOs in Europe and the United States: A Case-Study of Contemporary European Regulatory Politics* (2001), at <http://www.cfr.org/publication.php?id=3937> (arguing that European regulatory agencies, including those that govern genetically modified organisms, are taking fewer risks than they were in the 1960s); Symposium at the Pew Initiative on Food and Biotechnology, *Are the US and Europe Heading for a Food Fight over Genetically Modified Food?* (Oct. 24, 2001) (transcript available at <http://pewagbiotech.org/events/1024>) (acknowledging the divide between American and European attitudes toward genetically modified organisms and providing multiple possible reasons for it).

with carcinogens in food additives.⁵¹ In the context of occupational risk, American law is far more precautionary than, for example, Swedish law.⁵² The United States seems highly precautionary about terrorism and cigarette smoking, but less so about gun violence and obesity. I cannot venture a survey here, but it is reasonable to speculate that, in actual practice, nations cannot plausibly be ranked along some continuum of precaution. More plausibly, some nations are precautionary about some risks but not others, and a general adoption of the precautionary principle will conceal this inevitable fact.⁵³ I will return to this point and to its inevitability below,⁵⁴ because it is closely connected to my central claims here. Nonetheless, the mounting importance of the principle in Europe deserves close attention, if only because the idea of precaution is playing such a large role in public debates.

I have suggested that the weak versions of the precautionary principle are unobjectionable and important. Every day, people take steps (and incur costs) to avoid hazards that are far from certain. We do not walk in moderately dangerous areas at night; we exercise; we buy smoke detectors; we buckle our seatbelts; we might even avoid fatty foods. Sensible governments are willing to consider regulation of risks that, in individual cases or even in the aggregate, have well under a one hundred percent chance of coming to fruition. This is true for terrorist threats, environmental hazards, and much more. The weak versions of the precautionary principle state a truism, one that is uncontroversial and necessary only to combat public confusion or the self-interested claims of private groups demanding unambiguous evidence of harm, which no rational society requires. This function should not be trivialized. Nearly one-fifth of Americans, for example, recently agreed with the implausible suggestion that “[u]ntil we are sure that global warming is really a problem, we should not take any

⁵¹ See Richard Merrill, *FDA's Implementation of the Delaney Clause: Repudiation of Congressional Choice or Reasoned Adaptation to Scientific Progress?*, 5 YALE J. ON REG. 1, 9-12 (1988) (discussing the FDA's interpretation of the Delaney Clause, which banned carcinogens from being added to food if they posed a greater than one-in-one-million risk to humans).

⁵² See STEVEN KELMAN, *REGULATING AMERICA, REGULATING SWEDEN: A COMPARATIVE STUDY OF OCCUPATIONAL SAFETY AND HEALTH POLICY* 221 (1981) (concluding that during the 1960s and 1970s, American occupational regulations were stricter than those in Sweden).

⁵³ See Wiener & Rogers, *supra* note 48, at 342 (concluding that no blanket statement summarizes the precautionary policies of both the United States and the European Union, and that they must be looked at individually).

⁵⁴ *Infra* Part II.A.

steps that would have economic costs.”⁵⁵ Sometimes people do seem to seek certainty before showing a willingness to expend costs, and well-organized private groups like to exploit this fact. Insofar as the precautionary principle counteracts the tendency to demand certainty, it should be approved.

Consider in this regard the complex and generally quite sensible communication on the precautionary principle from the European Commission.⁵⁶ The communication urges that the principle “should be considered within a structured approach to the analysis of risk” that includes “risk assessment, risk management, [and] risk communication.”⁵⁷ Hence, measures based on the principle should not be blindly precautionary, but should be nondiscriminatory in application and consistent with similar measures previously taken.⁵⁸ More important, precautionary steps should be proportional to the chosen level of protection and “based on an examination of the potential benefits and costs of action or lack of action (including, where appropriate and feasible, an economic cost/benefit analysis).”⁵⁹ The idea of proportional response is a recognition of the fact that risk “can rarely be reduced to zero.”⁶⁰ The cost-benefit analysis sensibly recognizes the relevance of “non-economic considerations,” including public acceptability, and somewhat less sensibly urges “that the protection of health takes precedence over economic considerations.”⁶¹ The Commission also emphasizes the importance of a “scientific evaluation of the potential

⁵⁵ *Americans on the Global Warming Treaty*, Program on Int'l Policy Attitudes (Nov. 5, 1998), at http://www.pipa.org/OnlineReports/GlobalWarming/glob_warm_treaty.html.

⁵⁶ Communication from the Commission on the Precautionary Principle, *supra* note 47.

⁵⁷ *Id.* at 3.

⁵⁸ *See id.* at 4 (outlining six criteria with which measures based on the precautionary principle should be judged).

⁵⁹ *Id.*; *see also id.* at 19-20 (“A comparison must be made between the most likely positive or negative consequences of the envisaged action and those of inaction in terms of the overall cost to the [European] Community [R]equirements linked to the protection of public health should undoubtedly be given greater weight than economic considerations.”).

⁶⁰ *Id.* at 4.

⁶¹ *Id.* at 5. This is somewhat less sensible for two reasons: First, everything depends on degree; a very slight improvement in public health would not justify an enormous expenditure of money. Second, large expenditures are themselves associated with adverse health effects, a point elaborated *infra* text accompanying notes 113-20.

adverse effects” when considering whether to act.⁶² Indeed, recourse to the precautionary principle is said to presuppose “identification of potentially negative effects” alongside a “scientific evaluation” that shows inconclusive or imprecise data.⁶³ The Commission’s communication leaves many open questions, but insofar as it takes the precautionary principle to call for attention to potentially significant risks when the costs of control are not excessive or grossly disproportionate, it is entirely sensible.

Because the weak versions are sensible, I will not discuss them here. For the weak version, a principal current task is to find ways to match the extent of the evidence with the extent of the response. Weak evidence of harm, for example, might merely support further research, whereas somewhat stronger evidence might support public disclosure of the risk, and still stronger evidence might support regulatory controls. More refined calibration of evidence to response would be an important way to implement the weak version. But for present purposes, I will understand the principle in a strong way, to suggest that regulation is required whenever there is a possible risk to health, safety, or the environment, even if the supporting evidence is speculative and even if the economic costs of regulation are high. To avoid palpable absurdity, the idea of “possible risk” will be understood to require a certain threshold of scientific plausibility. To support regulation, no one thinks that it is enough if someone, somewhere, urges that a risk is worth taking seriously. But under the precautionary principle as I shall understand it, the threshold burden is minimal, and once it is met, there is something like a presumption in favor of stringent regulatory controls. I believe that this understanding of the precautionary principle fits with the understandings of many of its most enthusiastic proponents,⁶⁴ and that with relatively modest variations, this understanding fits with many of the legal formulations as well.⁶⁵

Why might the precautionary principle, understood in this strong sense, have such widespread appeal? At first glance, the answer is

⁶² Communication from the Commission on the Precautionary Principle, *supra* note 47, at 14.

⁶³ *Id.* at 15 (emphasis omitted). For an overview and critique, see Majone, *supra* note 1, at 106-07.

⁶⁴ For a compilation of essays supporting this understanding of the precautionary principle, see IMPLEMENTING THE PRECAUTIONARY PRINCIPLE, *supra* note 1.

⁶⁵ See Lothar Gündling, *The Status in International Law of the Principle of Precautionary Action*, 5 INT’L J. ESTUARINE & COASTAL L. 23, 26 (1990) (discussing precautionary actions as a stringent form of environmental policy).

simple, for the principle contains an important truth: sometimes it is much better to be safe than sorry. We should certainly acknowledge that a small probability (say, one in 100,000) of a serious harm (say, 100,000 deaths) deserves extremely serious attention. It is worthwhile to spend a lot of money to eliminate that risk. The fact that a danger is unlikely to materialize is hardly a decisive objection to regulatory controls that have a reasonable chance of success. Now an economically oriented critic might observe that our resources are limited and that if we spend large amounts of resources on highly speculative harms, we will not be allocating those resources wisely. In fact, this is the simplest criticism of the precautionary principle.⁶⁶ Unless the harm would be truly catastrophic, a huge investment makes no sense for a harm that has a one in one billion chance of occurring. Taken for all it is worth, the precautionary principle might seem to require indefensibly huge expenditures, exhausting our budget well before the menu of options could be consulted thoroughly.⁶⁷ If we take costly steps to address all risks, however improbable they are, we will quickly impoverish ourselves. On this view, the principle “would make for a dim future.”⁶⁸ This is no less true for nations than for individuals.

Some version of this argument is surely convincing, but it also seems to be missing something. How could a dim future possibly be compelled by the precautionary principle? Wouldn't the principle require “precaution” against that very future? Perhaps the response lies in certain facts about human cognition.⁶⁹ In some contexts, regulation is indeed a form of insurance, or a way of placing special locks on a door. Consider the following choice: Would you rather have

- (a) a sure loss of \$20; or
- (b) a one percent chance of losing \$1980?

In terms of expected value, (b), representing a statistical loss of \$19.80, is a bit less bad than (a); but most people would gladly choose the sure loss of \$20.⁷⁰ People do not like to run a small risk of a large or catastrophic loss; this is why people buy insurance and take special

⁶⁶ Cf. Graham, *supra* note 16, at <http://www.useu.be/RiskManagement/Jan1102GrahamUSRiskManagementPrecPrin.html> (cautioning that precaution can hamper innovation if abused by policymakers).

⁶⁷ See BJORN LOMBORG, *THE SKEPTICAL ENVIRONMENTALIST* 349 (2001) (suggesting that precautionary action may mean taking limited resources away from “doing good in other areas”).

⁶⁸ Morris, *supra* note 7, at 17.

⁶⁹ See Kahneman & Tversky, *supra* note 21, at 274 (introducing prospect theory as an alternative model to utility theory in decision making under risk).

⁷⁰ See *id.* at 263-67 (showing the desire to avoid low probability catastrophes).

precautions against serious harms, even in circumstances in which an analysis of expected value would not justify these steps.⁷¹ If government follows the judgments of ordinary people, it will be risk averse in this sense as well. The willingness to incur sure losses, in preference to low-probability catastrophes of lower expected value, helps explain decisions in a variety of domains involving both law and politics, including foreign policy.⁷²

This point about judgment under risk might seem to suggest that a democratic society, following popular views, will depart from the predictions of expected utility theory and even embody a form of risk aversion for low-probability catastrophes.⁷³ The result will be to move regulation in the direction suggested by the precautionary principle. But prospect theory cannot provide a defense of the principle in its strong form. I now explain why this is so.

II. WHY THE PRECAUTIONARY PRINCIPLE IS PARALYZING

A. *The Problem*

The most serious problem with the strong version of the precautionary principle is that it offers no guidance—not that it is wrong, but that it forbids all courses of action, including inaction. To understand this point, it will be useful to anchor the discussion in some concrete problems:

1. One of the most controversial environmental issues faced in the first year of the Bush administration involved the regulation of arsenic.⁷⁴ There is a serious dispute over the precise level of risks posed by low levels of arsenic in drinking water, but in the “worst case” sce-

⁷¹ For a lucid discussion, analyzing frivolous litigation in terms of risk behavior, see Chris Guthrie, *Framing Frivolous Litigation: A Psychological Theory*, 67 U. CHI. L. REV. 163 (2000).

⁷² See ROSE McDERMOTT, *RISK-TAKING IN INTERNATIONAL POLITICS: PROSPECT THEORY IN AMERICAN FOREIGN POLICY* 20-35 (1998) (discussing framing effects, their effect on decision making, and their applications to international politics); Guthrie, *supra* note 71, at 187-88 (summarizing why defendants prefer settlement to low-probability, high-loss litigation).

⁷³ See Roger G. Noll & James E. Krier, *Some Implications of Cognitive Psychology for Risk Regulation*, 19 J. LEGAL STUD. 747, 760-62 (1990) (positing that, in a majority-rule society, “citizens are willing to spend relatively too much on low-probability events as compared to ones of higher probability”).

⁷⁴ See Robert K. Musil, *Arsenic on Tap*, N.Y. TIMES, Apr. 24, 2001, at A18 (urging the importance of President Bush setting low maximum levels of arsenic in drinking water).

nario, over one hundred lives might be lost each year as a result of the fifty parts per billion (ppb) standard that the Clinton administration sought to revise.⁷⁵ At the same time, the proposed ten ppb standard would cost over two hundred million dollars each year, and it is possible that it would save as few as five lives annually.⁷⁶

2. Genetic modification of food has become a widespread practice.⁷⁷ But the risks of that practice are not known with precision.⁷⁸ Some people fear that genetic modification will result in serious ecological harm and large risks to human health.⁷⁹

3. Scientists are not in full accord about the dangers associated with global warming,⁸⁰ but there is general agreement that global warming is in fact occurring.⁸¹ It is possible that global warming will produce, by 2100, a mean temperature increase of 4.5 degrees Celsius,⁸² that it will result in well over five trillion dollars in annual monetized costs,⁸³ and that it will also produce a significant number of deaths from malaria. The Kyoto Protocol would require most industrialized nations to reduce greenhouse gas emissions to between ninety-two percent and ninety-four percent of 1990 levels.⁸⁴

4. Many people fear nuclear power on the grounds that nuclear power plants raise various health and safety issues, including some

⁷⁵ See Cass R. Sunstein, *The Arithmetic of Arsenic*, 90 GEO. L.J. 2255, 2258 (2002) (hypothesizing that the number of lives saved may be as many as 112 or as low as five).

⁷⁶ *Id.*

⁷⁷ See MCHUGHEN, *supra* note 27, at 1 (noting that genetically modified crops cover millions of acres and that Americans consume large quantities of genetically modified food).

⁷⁸ See *id.* at 129-35 (discussing how difficult it is to measure risk in this type of situation).

⁷⁹ See Gilland, *supra* note 50, at 60-83 (discussing the United Kingdom's moratorium on genetically modified crops in response to pressure from consumers and environmental groups and the scientific evidence of environmental risks).

⁸⁰ See WILLIAM D. NORDHAUS & JOSEPH BOYER, WARMING THE WORLD: ECONOMIC MODELS OF GLOBAL WARMING 71 (2000) ("In reviewing current research [on global warming], it is clear that the results are highly conjectural and that it continues to be difficult to make solid estimates of the impacts of climate change."); see also LOMBORG, *supra* note 67, at 260-320 (outlining the various arguments and experiments in support of them). Lomborg's own assessments are highly controversial, but it is noteworthy that a "skeptical" environmentalist takes global warming very seriously.

⁸¹ LOMBORG, *supra* note 67, at 261.

⁸² *Id.* at 317; see also NORDHAUS & BOYER, *supra* note 80, at 74 (using a benchmark of 2.5-degrees-Celsius warming).

⁸³ LOMBORG, *supra* note 67, at 317; see also NORDHAUS & BOYER, *supra* note 80, at 163 (finding discounted costs of four trillion dollars).

⁸⁴ See PERCIVAL ET AL., *supra* note 44, at 1141-42 (listing several nations' respective quantified emission limitation or reduction commitments).

possibility of catastrophe.⁸⁵ But if a nation does not rely on nuclear power, it might well rely instead on fossil fuels, and in particular on coal-fired power plants.⁸⁶ Such plants create risks of their own, including risks associated with global warming. China, for example, has relied on nuclear energy in part as a way of reducing greenhouse gases and in part as a way of reducing other air pollution problems.⁸⁷

5. There is a possible conflict between the protection of marine mammals and military exercises. The United States Navy, for example, engages in many such exercises, and it is possible that marine mammals will be threatened as a result. Military activities in the oceans might well cause significant harm, but a decision to suspend those activities, in cases involving potential harm, might also endanger military preparedness.⁸⁸

In these cases, what kind of guidance is provided by the precautionary principle? It is tempting to say, as is in fact standard, that the principle calls for strong controls on arsenic, on genetic engineering of food, on greenhouse gases, on threats to marine mammals, and on nuclear power.⁸⁹ In all of these cases, there is a possibility of serious

⁸⁵ See Robert Goodin, *No Moral Nukes*, 90 ETHICS 417, 420 (1980) (analyzing the risks associated with nuclear power).

⁸⁶ See Stephen Breyer, *Vermont Yankee and the Courts' Role in the Nuclear Energy Controversy*, 91 HARV. L. REV. 1833, 1835-36 (1978) (comparing the health effects of nuclear power with those of coal).

⁸⁷ See Ling Zhong, Note, *Nuclear Energy: China's Approach Towards Addressing Global Warming*, 12 GEO. INT'L ENVTL. L. REV. 493, 507-08 (2000) (describing how China has been using nuclear power to reduce various emissions). Of course it is possible, and even sensible, to urge that nations should reduce reliance on both coal-fired power plants and nuclear power, and move instead toward environmentally preferred alternatives, such as solar power. For a general discussion of this option, see ALLAN COLLINSON, *FACING THE FUTURE: RENEWABLE ENERGY* (1991); *RENEWABLE ENERGY: POWER FOR A SUSTAINABLE FUTURE* (Godfrey Boyle ed., 1996); Dan E. Arvizu, *Advanced Energy Technology and Climate Change Policy Implications*, 2 FLA. COASTAL L.J. 435 (2001). But these alternatives pose problems of their own, involving feasibility and expense. See LOMBORG, *supra* note 67, at 118-48 (discussing energy and nonenergy resources, including biomass, geothermal energy, wind, solar power, and hydroelectric power, but noting that each has its own limitations in terms of feasibility and/or expense).

⁸⁸ See *Marine Mammal Protection Act Reauthorization: Hearing on H.R. 4781 Before the Subcomm. on Fisheries Conservation, Wildlife & Oceans of the Comm. on House Res.*, 107th Cong. § 3 (2002) (statement of Vice Admiral Charles W. Moore, Deputy Chief of Naval Operations for Readiness and Logistics) [hereinafter Statement of Vice Admiral Charles W. Moore] (discussing the interplay between the needs of military readiness and environmental conservation), available at <http://resourcescommittee.house.gov/107congr/fisheries/2002jun13/moore.htm>.

⁸⁹ For examples of this position, see sources collected in the forty-third *INRA Courier of the Environment*, *Le Courrier de l'environnement de l'INRA*, Institut National de la Re-

harms, and no authoritative scientific evidence suggests that the possibility is close to zero. If the burden of proof is on the proponent of the activity or process in question, the precautionary principle would seem to impose a burden of proof that cannot be met. Put to one side the question of whether the precautionary principle, understood to compel stringent regulation in these cases, is sensible. Let us ask a more fundamental question: Is that more stringent regulation therefore compelled by the precautionary principle?

The answer is that it is not. In some of these cases, it should be easy to see that, in its own way, stringent regulation would actually run afoul of the precautionary principle. The simplest reason is that such regulation might well deprive society of significant benefits, and for that reason produce a large number of deaths that otherwise would not occur. In some cases, regulation eliminates the “opportunity benefits” of a process or activity, and thus causes preventable deaths.⁹⁰ If this is so, regulation is hardly precautionary. The most familiar cases involve the “drug lag,” produced by a highly precautionary approach to the introduction of new medicines and drugs into the market.⁹¹ If a government takes such an approach, it might protect people against harms from inadequately tested drugs; but it will also prevent people from receiving potential benefits from those very drugs.⁹² Is it “precautionary” to require extensive premarketing testing, or to do the opposite?

Or consider the case of genetic modification of food. Many people believe that a failure to allow genetic modification might well result in numerous deaths, and a small probability of many more.⁹³ The reason is that genetic modification holds out the promise of producing food that is both cheaper and healthier—resulting, for example, in “golden rice,” which might have large benefits in developing coun-

cherche Agronomique (National Institute of Agricultural Research) (May 2001), at <http://www.inra.fr/Internet/Produits/dpenv/som-ec43.html>.

⁹⁰ See AARON WILDAVSKY, *SEARCHING FOR SAFETY* 48-50 (1988) (explaining how attempts to secure safety may actually increase danger).

⁹¹ For analysis of the drug lag, see HENRY G. GRABOWSKI & JOHN M. VERNON, *THE REGULATION OF PHARMACEUTICALS: BALANCING THE BENEFITS AND RISKS* 38-41 (1983); John M. Mendeloff, *Decision Analysis and FDA Drug Review: A Proposal for “Shadow” Advisory Committees*, 6 *RISK* 203, 203-14 (1995), available at <http://www.fplc.edu/RISK/vol6/summer/mendelof.htm>.

⁹² For similar discussions regarding energy, see *supra* note 87.

⁹³ For an informative history, tracing but not endorsing the various objections to genetic modification, see BILL LAMBRECHT, *DINNER AT THE NEW GENE CAFÉ* (2001).

tries.⁹⁴ Now the point is not that genetic modification will definitely have those benefits or that the benefits of genetic modification outweigh the risks. The point is only that if the precautionary principle is taken in its strongest form, it is offended by regulation as well as by nonregulation. So too for regulation of ground-level ozone. Such regulation does seem justified by the precautionary principle, for responsible people believe that low levels of ozone produce a range of health harms, including risks of death.⁹⁵ But there is also evidence that ground-level ozone produces health benefits by reducing risks of cataracts and skin cancer.⁹⁶ Because the precautionary principle calls for protection when causal connections are unclear, it would appear to require, with respect to ground-level ozone, both stringent regulation and no regulation at all.

Sometimes regulation would violate the precautionary principle because it would give rise to *substitute risks*, in the form of hazards that materialize, or are increased, as a result of regulation.⁹⁷ Consider the case of nuclear power. It is reasonable to think that in light of current options, a ban on nuclear power will increase dependence on fossil fuels,⁹⁸ which contribute to global warming. If so, such a ban would seem to run afoul of the precautionary principle. Or consider the EPA's effort to ban asbestos,⁹⁹ a ban that might well seem justified or even compelled by the precautionary principle. The difficulty, from the standpoint of that very principle, is that substitutes for asbestos

⁹⁴ See *id.* at 294-310 (describing feeding the hungry as the ultimate argument in favor of genetically modified food and reviewing the Congressional Hunger Center's briefing on "golden rice" in the summer of 2000).

⁹⁵ See *Am. Trucking Ass'ns v. EPA*, 283 F.3d 355, 357-59 (D.C. Cir. 2002) (reviewing the correlation between low levels of ozone and adverse health effects).

⁹⁶ RANDALL LUTTER & HOWARD GRUENSPECHT, *ASSESSING BENEFITS OF GROUND-LEVEL OZONE: WHAT ROLE FOR SCIENCE IN SETTING NATIONAL AIR QUALITY STANDARDS? 1* (AEI-Brookings Joint Ctr. for Regulatory Studies, Regulatory Analysis No. 01-04, 2001), available at http://aei.brookings.org/publications/reganalyses/reg_analysis_01_04.pdf.

⁹⁷ See the discussion of risk-related tradeoffs in *RISK VERSUS RISK* (John D. Graham & Jonathan Baert Wiener eds., 1995); SUNSTEIN, *supra* note 45, at 133-52.

⁹⁸ See Breyer, *supra* note 86, at 1840 (suggesting that delays in the process of nuclear plant approval will lead to more use of fossil fuels, which also carry environmental dangers).

⁹⁹ See *Corrosion Proof Fittings v. EPA*, 947 F.2d 1201, 1207-08 (5th Cir. 1991) ("In 1989, the EPA issued a final rule [40 C.F.R. pt. 763 (1989)] prohibiting the manufacture, importation, processing, and distribution in commerce of most asbestos-containing products.").

also carry risks.¹⁰⁰ Or return to possible risks to marine mammals from the United States Navy. Some people are concerned that efforts to eliminate those risks will endanger military preparedness, if only because of administrative barriers to training exercises.¹⁰¹ In these circumstances, what is the appropriate approach, according to the precautionary principle?²

The problem is pervasive. The Administrator of the EPA has expressed concern that arsenic regulation, by virtue of its cost, will lead people to cease using local water systems and to rely on private wells, which have high levels of contamination.¹⁰² If this is so, stringent arsenic regulation violates the precautionary principle no less than less stringent regulation does. This is a common situation, for opportunity benefits and substitute risks are the rule, not the exception.¹⁰³ Or consider the continuing debate over whether certain antidepressants impose a (small) risk of breast cancer.¹⁰⁴ A precautionary approach might seem to caution against the use of such antidepressants because of their carcinogenic potential; but the failure to use those depressants might well impose risks of its own, both psychological and physical. Or consider the Soviet Union's decision to evacuate and relocate

¹⁰⁰ *Id.* at 1221 (“[M]any of the substitutes that . . . will be used in the place of asbestos have known carcinogenic effects . . .”).

¹⁰¹ See Statement of Vice Admiral Charles W. Moore, *supra* note 88, § 6 (suggesting that some efforts to protect marine mammals have affected the “ability to deploy mission-essential equipment and to train realistically for the challenges our country faces”).

¹⁰² The Administrator indicated:

[W]e have seen instances, particularly in the West and Midwest, where arsenic is naturally occurring at up to 700 and more parts per billion, where the cost of remediation has forced water companies to close, leaving people with no way to get their water, save dig wells. And then they are getting water that's even worse than what they were getting through the water company.

Interview by Robert Novak & Al Hunt, *Evans, Novak, Hunt & Shields*, Cable News Network, with Christine Todd Whitman, Administrator, EPA (Apr. 21, 2001).

¹⁰³ See, e.g., GOKLANY, *supra* note 3, at 13-27 (emphasizing the public health risks of banning DDT in the form of increasing malaria risks in the developing world). Note an important additional point: some regulation will have ancillary *benefits*, by reducing risks other than those that are specifically targeted. For a valuable discussion, see Samuel J. Rascoff & Richard L. Revesz, *The Biases of Risk Tradeoff Analysis: Towards Parity in Environmental and Health-and-Safety Regulation*, 69 U. CHI. L. REV. 1763 (2002).

¹⁰⁴ Compare Judith P. Kelly et al., *Risk of Breast Cancer According to Use of Antidepressants, Phenothiazines, and Antihistamines*, 150 AM. J. EPIDEMIOLOGY 861 (1999) (studying the relationship of the use of antidepressants, phenothiazines, and antihistamines on breast cancer rates and finding no overall association), with C.R. Sharpe et al., *The Effects of Tricyclic Antidepressants on Breast Cancer Risk*, 86 BRIT. J. CANCER 92 (2002) (concluding that heavy exposure to antidepressants increases the rate of breast cancer incidence).

400,000 people in response to the risk of adverse effects from the Chernobyl fallout.¹⁰⁵ It is not clear that, on balance, this massive relocation project was justified on health grounds: “A comparison ought to have been made between the psychological and medical burdens of this measure (anxiety, psychosomatic diseases, depression, and suicides) and the harm that may have been prevented.”¹⁰⁶ More generally, it is possible that a sensible government ignores low levels of radiation, on the grounds that precautionary responses are likely to cause fear that outweighs any health benefits from those responses.¹⁰⁷

Or consider a more general question about how to handle low-level toxic agents, including carcinogens: Do such agents cause adverse effects? If we lack clear evidence, it might seem “precautionary” to assume that they do, and hence to assume, in the face of uncertainty, that the dose-response curve is linear and without safe thresholds.¹⁰⁸ In fact, this is the default assumption of the EPA.¹⁰⁹ But is this approach actually precautionary? Some evidence suggests that many toxic agents that are harmful at high levels are actually beneficial at low levels.¹¹⁰ Thus, hormesis is a dose-response relationship in which low doses stimulate desirable effects and high doses inhibit them.¹¹¹ When hormesis is involved, use of a linear dose-response curve, without safe thresholds, will actually cause mortality and morbidity effects.

¹⁰⁵ Bellona Found., *Chernobyl—The Accident*, at http://www.bellona.no/en/environmental_facts_and_info/radioactivity_and_nuclear_power/12663.html (last visited Mar. 22, 2003).

¹⁰⁶ Maurice Tubiana, *Radiation Risks in Perspective: Radiation-Induced Cancer Among Cancer Risks*, 39 RADIATION & ENVTL. BIOPHYSICS 3, 10 (2000).

¹⁰⁷ *Id.* For some counterevidence, discussing a possible association between cellular telephones and cancer, see Lennart Hardell et al., *Further Aspects on Cellular and Cordless Phones and Brain Tumours*, 22 INT’L J. ONCOLOGY 399 (2003). For a helpful general discussion applying the precautionary principle in the context of electromagnetic radiation, see Leeka I. Kheifets et al., *The Precautionary Principle and EMF: Implementation and Evaluation*, 4 J. RISK RES. 113 (2000).

¹⁰⁸ For criticism of this assumption, see Tubiana, *supra* note 106, at 8-9.

¹⁰⁹ See National Primary Drinking Water Regulations, 66 Fed. Reg. 6976, 6994 (Jan. 22, 2001) (“After full consideration of public comments, EPA continues to believe that the most scientifically valid approach, given the lack of critical data, is to use the linear approach to assessing the mode of action.”).

¹¹⁰ This evidence is outlined in Edward J. Calabrese & Linda A. Baldwin, *Hormesis: The Dose-Response Revolution*, 43 ANN. REVS. PHARMACOLOGY & TOXICOLOGY 175 (2003) [hereinafter Calabrese & Baldwin, *Hormesis*], available at <http://pharmtox.annualreviews.org/cgi/reprint/43/1/175.pdf>; Edward J. Calabrese & Linda A. Baldwin, *The Hormetic Dose-Response Model Is More Common than the Threshold Model in Toxicology*, 71 TOXICOLOGICAL SCI. 246 (2003), available at <http://toxsci.oupjournals.org/cgi/reprint/71/2/246.pdf>.

¹¹¹ Calabrese & Baldwin, *Hormesis*, *supra* note 110, at 176-77.

Which default approach to the dose-response curve is precautionary?¹¹² To raise this question is not to take any stand on whether some, many, or all toxic agents are beneficial or instead harmful at very low doses; it is only to say that the simultaneous possibility of benefits at low levels and of harms at low levels makes the precautionary principle paralyzing.

It is possible to go much further. A great deal of evidence suggests the possibility that an expensive regulation can have adverse effects on life and health.¹¹³ To be sure, both the phenomenon and the underlying mechanisms are disputed.¹¹⁴ It has been urged that a statistical life can be lost for every expenditure of \$7.25 million,¹¹⁵ and one study suggests a cutoff point, for a loss of life per regulatory expenditure, of \$15 million.¹¹⁶ A striking paper suggests that poor people are especially vulnerable to this effect—that a regulation that reduces wealth for the poorest twenty percent of the population will have twice as large a mortality effect as a regulation that reduces wealth for the wealthiest twenty percent.¹¹⁷ I do not mean to accept any particular amount here, or even to suggest that there has been an unambiguous demonstration of an association between mortality and regulatory expenditures.¹¹⁸ The only point is that reasonable people believe in that association. It follows that a multimillion-dollar expenditure for “precaution” has—as a worst case scenario—significant

¹¹² For an interesting discussion of this question, see Frank B. Cross, *Legal Implications of Hormesis*, BELLE NEWSL. (Northeast Reg'l Envtl. Pub. Health Ctr., Amherst, Mass.), Jan. 2001, at 2, available at <http://www.belleonline.com/n2v92.html>.

¹¹³ See Ralph L. Keeney, *Mortality Risks Induced by Economic Expenditures*, 10 RISK ANALYSIS 147, 147 (1990) (“[S]ome expensive regulations and programs intended to save lives may actually lead to increased fatalities.”); Randall Lutter & John F. Morrall III, *Health-Health Analysis: A New Way to Evaluate Health and Safety Regulation*, 8 J. RISK & UNCERTAINTY 43, 43 (1994) (“Regulations to promote health and safety that are exceptionally costly relative to the expected health benefits may actually worsen health . . .”).

¹¹⁴ See Lutter & Morrall, *supra* note 113, at 57-60 (discussing the policy implications of using a health-health analysis of safety regulation versus a cost-benefit analysis).

¹¹⁵ Keeney, *supra* note 113, at 155.

¹¹⁶ ROBERT W. HAHN ET AL., DO FEDERAL REGULATIONS REDUCE MORTALITY? 7 (2000).

¹¹⁷ Kenneth S. Chapman & Govind Hariharan, *Do Poor People Have a Stronger Relationship Between Income and Mortality than the Rich? Implications of Panel Data for Health-Health Analysis*, 12 J. RISK & UNCERTAINTY 51, 59-60 (1996).

¹¹⁸ Cf. Paul R. Portney & Robert N. Stavins, *Regulatory Review of Environmental Policy: The Potential Role of Health-Health Analysis*, 8 J. RISK & UNCERTAINTY 111, 118 (1994) (arguing that adverse health effects from the cost of regulation are possible but unlikely).

adverse health effects, with an expenditure of \$200 million leading to perhaps as many as thirty lives lost.

This point makes the precautionary principle hard to implement not merely where regulation removes “opportunity benefits” or introduces or increases substitute risks, but also in any case in which the regulation costs a significant amount. If this is so, the precautionary principle, for that very reason, seems to argue against many regulations. If the precautionary principle draws into doubt any action that carries a small risk of significant harm, then we should be reluctant to spend a lot of money to reduce risks, simply because those expenditures themselves carry risks. Here is the sense in which the precautionary principle, taken for all that it is worth, is paralyzing: it stands as an obstacle to regulation and nonregulation, and to everything in between.

To say this is not to say that the precautionary principle cannot be amended in a way that removes the problem.¹¹⁹ But once it is so amended, it is much less distinctive and increasingly resembles an effort to weigh the health benefits of regulation against the health costs,¹²⁰ or even to measure benefits against costs. I will return to this point below.

It is now easier to understand the earlier suggestion that despite their formal enthusiasm for the precautionary principle, European nations are not “more precautionary” than the United States. Jonathan Wiener and Michael Rogers have demonstrated this point empirically.¹²¹ It would be most valuable to attempt a comparative study, to see which nations are especially precautionary with respect to specific risks, and also to explore changes over time. In the modern period, for example, the United States has appeared to take a highly precautionary approach to the risks associated with abandoned hazardous waste dumps,¹²² terrorism, and universal health care, but not to

¹¹⁹ For various efforts to amend the precautionary principle, see GOKLANY, *supra* note 3, at 89-94; Wiener, *supra* note 3, at 1513-18.

¹²⁰ See John D. Graham & Jonathan Baert Wiener, *Confronting Risk Tradeoffs*, in RISK VERSUS RISK, *supra* note 97, at 1, 10-11 (discussing the assessment of health risks and tradeoffs).

¹²¹ See Wiener & Rogers, *supra* note 48, at 317 (concluding that “neither the [European Union] nor the [United States] can claim to be categorically ‘more precautionary’ than the other”).

¹²² See JAMES T. HAMILTON & W. KIP VISCUSI, CALCULATING RISKS? 129 (MIT Sloan Sch. of Mgmt., Regulation of Economic Activity Series No. 21, 1999) (indicating that “individuals appear to be willing to spend approximately \$5 million to save a statistical life,” yet “regulators at Superfund sites appear to make cleanup decisions that imply a

take a highly precautionary approach to the risks associated with global warming, indoor air pollution, poverty, and obesity. What I have been urging is that the selectivity of precautions is not merely an empirical fact; it is a conceptual inevitability. Simply as a logical matter, no society can be highly precautionary with respect to all risks.

B. *Rejoinders, Adjustments, and Salutary Goals*

Is there anything that might be said, at this stage, by proponents of the precautionary principle? There are several possibilities.

1. The Weak Version and Balancing

It might be tempting to revert to the weak version of the principle—a version that is entirely unobjectionable. As we have seen, the version adopted by the European Commission is less troublesome than the strongest versions.¹²³ Alternatively, it might be urged that in many cases in which the principle is invoked, the risk at issue is the one that deserves the most sustained attention. In the context of global warming, for example, the precautionary principle might be triggered on the grounds that the potential risks of warming are far greater than the risks associated with the reduction of greenhouse gases. But this step points toward a sensible and substantial refashioning of the principle, one that ensures that low-probability catastrophes are given careful attention, and that the various risks at issue will be weighed and balanced in accordance with the facts.

Another kind of sensible balancing is embodied in the notion of “prudent avoidance,” which asks people to take steps that have only modest costs.¹²⁴ So long as requests for prudent avoidance do not activate a great deal of public fear, it makes sense to favor inexpensive measures that reduce potential risks. If the precautionary principle merely calls for prudent avoidance, it embodies a form of reasonable balancing and should not be rejected.

cost per cancer case averted that is often in the hundreds of millions of dollars and even the billions”).

¹²³ See *supra* text accompanying notes 56-63 (arguing that the Commission’s version is sensible).

¹²⁴ Kheifets et al., *supra* note 107, at 120.

2. Biases

In addition, advocates of the precautionary principle might urge that environmental values are systematically disregarded in the regulatory process, or not given their due, and hence that the principle helps counteract systematic biases.¹²⁵ A particular problem here is myopia¹²⁶: perhaps government officials, uninformed by the precautionary principle, would fail to attend to risks that will not occur, or be seen to occur, in the short run. Another problem is that people tend to be unrealistically optimistic.¹²⁷ As a result, many low-level risks do not register at all. A related problem is that people tend to reduce cognitive dissonance, sometimes by treating risks as if they are tiny, even worth ignoring.¹²⁸ When people think that they are “safe,” even though they face a statistical risk, they might well be responding to emotions, seeking to avoid the anxiety that comes from an understanding of the inevitability of risk.

On this view, the principle can be defended pragmatically, if not theoretically, as a way of emphasizing the importance of attending to issues, especially environmental issues, that might otherwise be neglected. In some settings, the pragmatic defense is undoubtedly plausible, and the precautionary principle, applied with a narrow viewscreen, undoubtedly leads to some good results. But two problems remain. The first is that environmental values are sometimes on both sides of the controversy—consider the nuclear power dispute. The same is certainly true of health and safety, as shown by the case of premarket testing of pharmaceuticals. The second is that even when

¹²⁵ See, e.g., Richard B. Stewart, *Regulation in a Liberal State: The Role of Non-Commodity Values*, 92 YALE L.J. 1537, 1566-87 (1983) (discussing the noncommodity value of environmental resources and theorizing why governments have difficulty incorporating these values into their regulatory schemes).

¹²⁶ See the treatment of hyperbolic discounting in Christine Jolls et al., *A Behavioral Approach to Law and Economics*, 50 STAN. L. REV. 1471, 1479, 1539-41 (1998); Richard H. Thaler, *Some Empirical Evidence on Dynamic Inconsistency*, 8 ECON. LETTERS 201 (1981), reprinted in RICHARD H. THALER, *QUASI RATIONAL ECONOMICS* 127 (1991).

¹²⁷ See SHELLEY E. TAYLOR, *POSITIVE ILLUSIONS* 7 (1989) (“[N]ormal human thought and perception is marked not by accuracy but by positive self-enhancing illusions about the self, the world, and the future.”). Some doubts about the claim of unrealistic optimism are raised in Cass R. Sunstein, *Hazardous Heuristics*, 70 U. CHI. L. REV. (forthcoming May 2003) (reviewing HEURISTICS AND BIASES: THE PSYCHOLOGY OF INTUITIVE JUDGMENT (Thomas Gilovich et al. eds., 2002)).

¹²⁸ See George A. Akerlof & William T. Dickens, *The Economic Consequences of Cognitive Dissonance*, 72 AM. ECON. REV. 307, 309 (1982) (noting that workers employed in a dangerous field “will try to reject the cognition that the job is dangerous”), reprinted in GEORGE A. AKERLOF, *AN ECONOMIC THEORIST’S BOOK OF TALES* 123, 126 (1984).

environmental values are on only one side, the interests and values on the other side might well be at a comparative disadvantage too—consider the potential beneficiaries of genetic modification of food. In short, a more modest and revised precautionary principle might well make sense, but the less modest, and more distinctive, principle is hard to defend.

3. Distribution

It is also possible to defend the precautionary principle on distributional grounds. The Clean Air Act takes a precautionary approach, requiring an “adequate margin of safety” and hence regulation in the face of scientific uncertainty.¹²⁹ At the same time, the Clean Air Act appears to give disproportionate benefits to poor people and members of minority groups.¹³⁰ Aggressive action to combat climate change could well be more beneficial to poor countries than to wealthy ones.¹³¹ This is partly because wealthy countries are better able to adapt; partly because agriculture, potentially vulnerable to climate change, is responsible for a smaller percentage of the economy of wealthy nations (less than five percent of the GDP in the United States)¹³² than of poor nations;¹³³ and partly because one of the most serious health risks posed by climate change consists of an in-

¹²⁹ 42 U.S.C. § 7409(b)(1) (2000); see *Am. Trucking Ass'ns v. EPA*, 283 F.3d 355, 380 (D.C. Cir. 2002) (“[N]othing in the Clean Air Act requires EPA to wait until it has perfect information before adopting a protective secondary [national air quality standard].”). For a qualified defense of the precautionary principle, focused on the possibility that “scientific uncertainty should not disadvantage potential victims,” see Mark Geistfeld, *Implementing the Precautionary Principle*, 31 *Envtl. L. Rep.* (Envtl. L. Inst.) 11,326, 11,333 (Nov. 2001).

¹³⁰ See Matthew E. Kahn, *The Beneficiaries of Clean Air Act Regulation*, REGULATION, Spring 2001, at 34, 35-37 (claiming that air quality improvements disproportionately help the poor and that wealthier purchasers of new vehicles are shouldering a disproportionate amount of the financial burden brought about by Clean Air Act regulation).

¹³¹ See, e.g., LOMBORG, *supra* note 67, at 301 (contending that the cost of global warming will be two to nine times greater in the developing world measured as a percentage of the GDP); Joseph E. Aldy et al., *Climate Change: An Agenda for Global Collective Action 7* (October 2001) (unpublished manuscript) (arguing that wealthier countries have more resources and technology to help them adjust to climate changes), available at <http://www.pewclimate.org/media/stiglitz.pdf>.

¹³² *Global Warming—Impacts: Agriculture*, EPA, at <http://yosemite.epa.gov/oar/globalwarming.nsf/content/impactsagriculture.html> (last modified Jan. 29, 2003).

¹³³ See *The Regional Impacts of Climate Change*, Intergovernmental Panel on Climate Change, at <http://www.grida.no/climate/ipcc/regional/156.htm> (indicating that eighteen percent of the GDP of “Middle East and Arid Asia Regions” is derived from agriculture).

creased incidence of malaria, a nonproblem for wealthy countries.¹³⁴ In the context of global warming, at least, the precautionary principle might be invoked to prevent especially severe burdens on those in the worst position to bear them.

Of course, it makes sense to be concerned with the distribution of domestic or international risks. The problem of global warming owes its origin to the actions of wealthy nations, and hence those nations should bear a disproportionate cost of correction if poor nations are likely to be hit hardest. The distributional effects of global warming are among the strongest points in favor of aggressive regulation of greenhouse gases.¹³⁵ But in many cases, the precautionary principle, as applied, would threaten to have unfortunate distributional effects.¹³⁶ The case of genetic modification of food is an example; here the benefits are likely to be enjoyed by poor people, not the wealthy.¹³⁷ The case of DDT is similar. While a ban on DDT, supported by reference to the precautionary principle, is eminently justified in wealthy nations, such a ban is likely to have deleterious effects in at least some poor countries, where DDT is the cheapest and most effective way of combating serious diseases—most notably malaria.¹³⁸ Or consider the following possibility: The precautionary principle might seem to require stringent limits on aflatoxin, a known carcinogen, coming into Europe and America from Africa. But European Community standards are so stringent in this regard that they are projected to prevent only one death per year in the EU—a small number in the abstract, and evidently trivial in light of the fact that 33,000 people die annually from liver cancer in the EU.¹³⁹ And precaution has its costs, imposing

¹³⁴ LOMBORG, *supra* note 67, at 292.

¹³⁵ Note, however, that if the concern is poor countries, it is not entirely clear that global warming is the highest priority in light of the many needs of those countries, needs that might be addressed by wealthier nations. *See id.* at 322-23 (arguing that direct subsidies from wealthy to poor nations would benefit poor nations more than reductions in greenhouse gas emissions).

¹³⁶ *See* GOKLANY, *supra* note 3, at 86 (concluding that a policy of aggressive greenhouse gas emission controls would adversely affect developing countries).

¹³⁷ *See id.* at 55 (arguing that the costs of reducing or banning the use of genetically modified crops “would be borne by the poorest and most vulnerable segments of society”). I am assuming here that poor people will benefit because of the increased availability of nutritious, low-cost food. This is of course an optimistic and disputable view about the facts.

¹³⁸ SUNSTEIN, *supra* note 45, at 14; *see* AARON WILDAVSKY, BUT IS IT TRUE?: A CITIZEN’S GUIDE TO ENVIRONMENTAL HEALTH AND SAFETY ISSUES 56 (1995) (explaining that DDT is an inexpensive and highly effective way to kill the mosquitoes that carry malaria and the agents that spread typhus fever).

¹³⁹ Majone, *supra* note 1, at 106.

significant losses on African farmers, whose ability to export food is severely compromised by the European Community's requirements.¹⁴⁰ Here, then, is a case in which the precautionary principle has perverse distributional consequences. Distributional issues should indeed be a part of a system of risk regulation, but the precautionary principle is a crude, indirect, and sometimes perverse way of incorporating distributional concerns.

4. Risk Versus Uncertainty

A more subtle point is possible. Often regulators, and ordinary people, are acting in a situation not of *risk* (where probabilities can be assigned to various outcomes) but of *uncertainty* (where no such probabilities can be assigned).¹⁴¹ Thus far I have been speaking as if environmental and other risk-related problems involved a risk of ascertainable probability—so that analysts are able to say that the risk of X number of deaths is Y percent, whereas the risk of $2X$ number of deaths is Y/n , and so forth. But we can imagine instances in which analysts cannot specify even a range of probability, and in which the extent of the harm is also not susceptible to even vague probabilistic prediction.¹⁴²

In a situation of uncertainty, when existing knowledge does not permit regulators to assign probabilities to outcomes, it is standard to follow the minimax principle: Choose the policy with the best worst-case outcome.¹⁴³ Perhaps the precautionary principle, as applied, is a form of the minimax principle, asking officials to identify the worst case among the various options, and to select that option whose worst case is least bad. Perhaps the minimax principle would support many

¹⁴⁰ See *id.* (“World Bank economists estimate that the new [aflatoxin] standards would decrease African exports of cereals, dried fruits and nuts to the EU by 64 percent . . .”).

¹⁴¹ See FRANK H. KNIGHT, RISK, UNCERTAINTY AND PROFIT 19-20 (1921) (noting that measurability separates risk from uncertainty); Paul Davidson, *Is Probability Theory Relevant for Uncertainty? A Post Keynesian Perspective*, J. ECON. PERSP., Winter 1991, at 129, 137 (discussing the distinction between the “probability calculus” and conditions of uncertainty). The distinction between uncertainty and risk is challenged by Majone, *supra* note 1, at 103. On the distinction between risk, uncertainty, and ignorance (knowing neither probability nor all of the outcomes), see *Twelve Late Lessons, in THE PRECAUTIONARY PRINCIPLE IN THE 20TH CENTURY, supra* note 19, at 185, 188.

¹⁴² See Stewart, *supra* note 42, at 73 (characterizing these instances as where “the probability of harm occurring, and/or the magnitude of the harm if it occurs, is not determinate and is subject to substantial uncertainty”).

¹⁴³ See JON ELSTER, EXPLAINING TECHNICAL CHANGE 185-207 (1983), for a helpful discussion of the minimax principle.

proposed applications of the precautionary principle, by, for example, urging aggressive steps to combat global warming.

This is not an implausible suggestion; sometimes it is best to respond to the worst-case scenario, as some governments do in the face of risks to national security (not excluding those risks posed by terrorism). But the response faces three problems. The first is that the precautionary principle is not the minimax principle, and if the latter principle is what is meant, then we should be discussing that principle directly and evaluating it against the alternatives. The precautionary principle obscures these issues. The second problem is that, so defended, the principle might well prevent rational priority setting, simply because it “leads to a disproportionate allocation of limited regulatory resources to those activities posing relatively more uncertainty, because the worst case assumption inflates their harm value relative to risks that are better characterized.”¹⁴⁴ The third problem is that risks that are now in the realm of uncertainty will often move, over time, into the realm of risk. Indeed, one of the principal goals of a well-functioning system of environmental protection is to acquire more information about potential hazards—information that includes an understanding of the probability of harm. In some circumstances, acquiring information is far better than responding to the worst-case scenario, at least when that response itself creates dangers in the realm of both uncertainty and risk.¹⁴⁵

5. Salutary Goals

We are now in a position to appreciate some of the goals of those who invoke the precautionary principle. Serious environmental problems might be addressed too late, or not at all, simply because causal connections cannot be described with certainty. In the context of tobacco, for example, a serious public health movement was muted simply by virtue of both actual and perceived scientific doubt¹⁴⁶—even though reasonable people take steps to reduce likelihoods, not only

¹⁴⁴ Stewart, *supra* note 42, at 97.

¹⁴⁵ See *id.* at 106 (advocating this approach to “help ensure that regulatory decisions are made on the basis of more accurate estimations of costs and benefits, which will in turn make it more likely that such decisions will enhance social welfare”).

¹⁴⁶ Cf. ROBERT E. GOODIN, NO SMOKING: THE ETHICAL ISSUES 8-15 (1989) (detailing the scientific studies and theories used to show the harm caused by cigarettes and those used to cast doubt). To some extent, of course, tobacco companies manipulated and misstated the evidence, but it is also true that, at early stages, the scientific evidence was suggestive rather than conclusive.

certainties, of adverse effects. The precautionary principle can be taken as a reminder not to require proof. To the extent that the precautionary principle is a reminder of obligations to the future, it is entirely salutary. Those who invoke the principle undoubtedly are motivated, much of the time, by the goal of protecting the most vulnerable people against risks to their safety and health. On this view, the precautionary principle has strong moral goals, and they are distributive in character.

Nothing I have said is meant to draw these goals into doubt. My claim is that the precautionary principle is a crude and sometimes perverse way of promoting the relevant goals—and that if it is taken seriously, it is paralyzing and therefore not helpful at all.¹⁴⁷

III. THE OPERATION OF THE PRECAUTIONARY PRINCIPLE: A BEHAVIORAL ACCOUNT

In practice, the precautionary principle is widely thought to provide concrete guidance.¹⁴⁸ How can this be? I suggest that the principle becomes operational if and only if those who apply it wear blinders—only, that is, if they focus on some aspects of the regulatory situation but downplay or disregard others. Consider, for example, those who think that the precautionary principle requires restrictions on genetic engineering of food; to have this belief, it is necessary to ignore the potential health benefits of the practice. Or consider those

¹⁴⁷ Of course it is possible that strong regulatory controls will turn out to be “technology forcing”—that they will promote technological innovation to the benefit of the environment and public health. See PERCIVAL ET AL., *supra* note 44, at 604-20 (discussing technological innovation brought about by national regulation of mobile source emissions). If the precautionary principle leads to such controls, it might be desirable for that reason. The problem is that technological innovation might be expensive or even infeasible, and if this is so, it might produce risks of its own. Suppose, for example, that the government, concerned about the hazards associated with coal-fired power plants, required a great deal of technological innovation to reduce those hazards. The resulting regulation might well increase the cost of energy, possibly significantly, and increased energy costs create risks of their own. None of this means that technology forcing is always a bad idea. The problem is that the precautionary principle, if used to force technological innovation, does not tell us when and where such innovation should be required.

¹⁴⁸ See, e.g., Ken Geiser, *Establishing a General Duty of Precaution in Environmental Protection Policies in the United States*, in IMPLEMENTING THE PRECAUTIONARY PRINCIPLE, *supra* note 1, at xxi, xxv (“The Precautionary Principle offers the practicality that a general principle of environmental protection lacks. . . . [T]he precautionary approach creates an obligation to consider competing options and to act cautiously whenever possible. This is the responsibility that is currently missing . . . throughout U.S. environmental policy.”).

who think that the precautionary principle calls for stringent regulation of greenhouse gases; such people neglect the need to adopt precautions against the very risks introduced by stringent regulation. In the same vein, those who invoke the precautionary principle to seek regulation of human cloning neglect the possibility that, without therapeutic cloning, many people will die.¹⁴⁹

But these points simply raise an additional question: Why is the precautionary principle so influential? Why does it speak to so many people? I believe that much of the answer lies in an understanding of behavioral economics and cognitive psychology. Five points are especially pertinent. Taken together, they help explain the kinds of blinders that people wear when they use the precautionary principle to support concrete outcomes. The points help show the sense in which the relevant blinders are not arbitrary or coincidental. They have some unmistakable structure.

A. *Loss Aversion and Familiarity*

People tend to be loss averse, which means that a loss from the status quo is seen as more undesirable than a gain is seen as desirable.¹⁵⁰ To see how loss aversion works, consider some of the classic experiments, which involve the endowment effect.¹⁵¹ People who were initially endowed with certain goods—such as coffee mugs, chocolate bars, and binoculars—valued those goods far more than those who were not initially endowed with them. The reason for the endowment effect is loss aversion: people are much more distressed by the prospect of loss than they are pleased by the prospect of equivalent gain.¹⁵² Another way to put the point is to say that contrary to economic the-

¹⁴⁹ See Statement of Dr. Brent Blackwelder, *supra* note 40 (arguing in favor of following the precautionary principle with respect to human cloning).

¹⁵⁰ See Colin Camerer, *Individual Decision Making*, in THE HANDBOOK OF EXPERIMENTAL ECONOMICS 588, 665-70 (John H. Kagel & Alvin E. Roth eds., 1995) (discussing the endowment effect, which arises from loss aversion and creates gaps between the prices at which a person is willing to buy and sell an identical object); Daniel Kahneman et al., *Experimental Tests of the Endowment Effect and the Coase Theorem*, 98 J. POL. ECON. 1325, 1327-28 (1990) (discussing the asymmetry created by loss aversion whereby owners will evaluate goods at a higher price than will buyers); Richard Thaler, *The Psychology of Choice and the Assumptions of Economics*, in LABORATORY EXPERIMENTATION IN ECONOMICS 99, 105 (Alvin E. Roth ed., 1987) (arguing that “losses loom larger than gains”), *reprinted in* THALER, *supra* note 126, at 137, 143.

¹⁵¹ See Kahneman et al., *supra* note 150, at 1329-42 (discussing several of these experiments).

¹⁵² Of course, loss aversion itself remains to be explained. For a relevant discussion, see Cass R. Sunstein, *Switching the Default Rule*, 77 N.Y.U. L. REV. 106 (2002).

ory, people do not value out-of-pocket costs and opportunity costs the same. Opportunity costs, as forgone gains, seem to be far less bad, on a per-dollar basis, than out-of-pocket costs.

In the context of risk regulation, there is a clear implication: people will be closely attuned to the losses produced by any newly introduced risk, or any aggravation of existing risks, but far less concerned with the benefits that are forgone as a result of regulation. I believe that loss aversion helps to explain what makes the precautionary principle operational: the opportunity costs of regulation often register little or not at all, whereas the out-of-pocket costs of the activity or substance in question are entirely visible. In fact, this is a form of status quo bias.¹⁵³ The status quo marks the baseline against which gains and losses are measured, and a loss from the status quo seems much more bad than a gain from the status quo seems good.

If loss aversion is at work, we would predict that the precautionary principle would place a spotlight on the losses introduced by some risk and downplay the benefits forgone as a result of controls. In fact, this is what we have observed in several contexts. In the context of genetic engineering of food, this is very much the situation.¹⁵⁴ Whenever the “opportunity benefits” are off-screen, this will be the reason that the precautionary principle appears to give guidance notwithstanding the objections I have made. At the same time, the neglected opportunity benefits present a devastating problem with the use of the precautionary principle. We can find this problem when the precautionary principle is invoked to support bans on nonreproductive cloning.¹⁵⁵ For many people, the possible harms of cloning register more strongly than the potential therapeutic benefits that would be eliminated by a ban on the practice.

Loss aversion is closely associated with another cognitive finding: *people are far more willing to tolerate familiar risks than unfamiliar ones, even*

¹⁵³ See William Samuelson & Richard Zeckhauser, *Status Quo Bias in Decision Making*, 1 J. RISK & UNCERTAINTY 7, 45-46 (1988) (arguing that the status quo persists in part because “potentially compensable changes have no moral standing”).

¹⁵⁴ See Katherine Barrett & Gabriela Flora, *Genetic Engineering and the Precautionary Principle*, GERMINATOR (N. Plains Sustainable Agric. Soc’y, Fullerton, N.D.), Mar. 2000 (explaining that the precautionary principle still applies even though genetically altered foods have already been planted around the globe), <http://www.npsas.org/GEPrecautionary.html>.

¹⁵⁵ See, e.g., Statement of Dr. Brent Blackwelder, *supra* note 40 (applying the precautionary principle to cloning).

if they are statistically equivalent.¹⁵⁶ The risks associated with driving do not occasion a great deal of concern, even though tens of thousands of people die from motor vehicle accidents each year. The relevant risks are simply seen as part of life. By contrast, many people are quite concerned about risks that appear newer, such as the risks associated with genetically modified foods, recently introduced chemicals, nuclear power plants, and terrorism. Part of the reason for the asymmetry may be a belief that, with new risks, we are in the domain of uncertainty rather than risk, and hence it makes sense to be cautious when probabilities cannot be assigned. But the individual and social propensity to focus on new risks outruns that sensible propensity; it makes the precautionary principle operational by emphasizing a subset of the hazards actually involved.

B. *The Mythical Benevolence of Nature*

Sometimes the precautionary principle operates by incorporating the belief that nature is essentially benign and that human intervention is likely to carry risks—as in the suggestion that the precautionary principle calls for stringent regulation of pesticides. This is a distinctive form of loss aversion. The idea is that any human intervention will create loss from the status quo, and that this loss should carry great weight, whereas the gains should be regarded with some suspicion or at least be taken as less weighty. Often loss aversion and a belief in nature's benevolence march hand-in-hand: nature's status quo forms the baseline or reference state against which to assess deviations. Processes that interfere with nature seem, on the part of many, to be taken as troubling "degradation"—whereas gains or improvements seem, other things being equal, far less significant.

A belief in the benevolence of nature does play a role in the operation of the precautionary principle, especially among those who see nature as harmonious or in balance. In fact, many of those who

¹⁵⁶ See Paul Slovic et al., *Facts and Fears: Understanding Perceived Risk*, in SOCIETAL RISK ASSESSMENT: HOW SAFE IS SAFE ENOUGH? 181, 200-03 (Richard C. Schwing & Walter A. Albers, Jr., eds., 1980) (summarizing study results statistically proving this point). Note also that people have been found to show less concern for risks that seem voluntary and controllable, see Baruch Fischhoff et al., *How Safe Is Safe Enough? A Psychometric Study of Attitudes Towards Technological Risks and Benefits*, 9 POL'Y SCI. 127, 143 (1978) ("[F]or any given level of benefit, greater risk was tolerated if that risk was voluntary, immediate, known precisely, controllable and familiar."), reprinted in SLOVIC, *supra* note 24, at 80, 94, and the risks from driving might so appear. On some relevant complexities in risk perception, suggesting that there is no simple dichotomy between voluntary and involuntary risks, see SUNSTEIN, *supra* note 45, at 67-72.

endorse the principle seem to be especially concerned about new technologies. Certainly most people believe that natural chemicals are more safe than manmade chemicals.¹⁵⁷ (Most toxicologists disagree.)¹⁵⁸ On this view, the principle calls for caution when people are intervening into the natural world. Here of course we can find some sense: Nature often consists of systems, and interventions into systems can cause a number of problems. New technologies may produce unintended bad effects, if only because they interfere with systems. But there is a large problem with this understanding of the precautionary principle. What is natural may not be safe at all.¹⁵⁹

Consider, for example, the idea that there is a “balance of nature.” According to one account, this idea is not true.¹⁶⁰ A scientific “revolution” has shown that nature “is characterized by change, not constancy,”¹⁶¹ and that “natural ecological systems are dynamic,” with desirable changes including “those induced through human action.”¹⁶² In any case, nature is often a realm of destruction, illness, killing, and death.¹⁶³ Hence the claim cannot be that human activity is necessarily or systematically more destructive than nature. Nor is it clear that natural products are comparatively safe.¹⁶⁴ Organic foods, favored by

¹⁵⁷ See Nancy Kraus et al., *Intuitive Toxicology: Expert and Lay Judgments of Chemical Risks*, 12 RISK ANALYSIS 215, 220 (1992) (verifying the “commonly held belief that the public has much more confidence in the safety of natural (as opposed to synthetic) chemicals than do the experts”), reprinted in SLOVIC, *supra* note 24, at 285, 295.

¹⁵⁸ See *id.* at 221 (stating that eighty-five percent of surveyed toxicologists disagreed with the statement, “Natural chemicals, as a rule, are not as harmful as man-made chemicals”).

¹⁵⁹ See COLLMAN, *supra* note 22, at 1-2, 155-57 (discussing popular underestimation of the true risks of natural toxins); see also Paul Rozin, *Technological Stigma: Some Perspectives from the Study of Contagion*, in RISK, MEDIA AND STIGMA: UNDERSTANDING PUBLIC CHALLENGES TO MODERN SCIENCE AND TECHNOLOGY 31, 38 (James Flynn et al. eds., 2001) (urging that “more lives are lost to natural than to man-made disasters” but referring to evidence of “lay overestimation of carcinogenic risk from pesticides, and underestimation of the risks from natural carcinogens”).

¹⁶⁰ See Daniel P. Botkin, *Adjusting Law to Nature's Discordant Harmonies*, 7 DUKE ENVTL. L. & POL'Y F. 25, 27 (1996) (asserting that the “myth” of the “balance of nature” has been “demonstrated as part of the revolution in environmental sciences”).

¹⁶¹ *Id.*

¹⁶² *Id.* at 31.

¹⁶³ For a detailed elaboration on this point, describing the violent indignities visited upon the human race by nature, see JOHN STUART MILL, *Nature*, in THREE ESSAYS ON RELIGION 3, 28-31 (AMS Press 1970) (1874).

¹⁶⁴ See COLLMAN, *supra* note 22, at 7-37 (discussing the harmful potential of common foods, including breads and cereals, spices, and organic produce). Perhaps the public is more comfortable with gradual changes than with large deviations, though this speculation has not, to my knowledge, been tested. Natural processes might seem more benign because they have their own rhythms, with which human interventions

many people on grounds of safety and health and creating annual revenues of \$4.5 billion in the United States alone, have been said to be “actually riskier to consume than food grown with synthetic chemicals.”¹⁶⁵ If the precautionary principle is seen to raise doubts about pesticides, but not about organic foods, it is probably because the health risks that come with significant departures from “nature” register as especially troublesome.

Of course, some of the most serious risks are a product of nature. Tobacco smoking kills 400,000 Americans each year; the precautionary principle might be (but has not been) directed against it. Nothing is more natural than exposure to sunlight, but such exposure is associated with skin cancer and other harms,¹⁶⁶ producing serious health problems that have not always been the occasion for invoking the precautionary principle. Studies suggest that of deaths attributable to ionizing radiation, the vast majority come from natural rather than man-made sources, with only twenty-five out of 1265 annual cancer deaths in England from such radiation coming from human sources.¹⁶⁷ To say this is not to resolve specific issues, which depend on complex questions of value and fact. My only suggestion is that the false belief in a benevolence of nature helps to explain why the pre-

may or may not fit, depending on their abruptness. To a generalist, it certainly seems reasonable to urge a kind of “abruptness heuristic,” in accordance with which rapid, large-scale changes seem particularly dangerous. The problem is that many man-made interventions create slow, incremental changes, while nature sometimes creates rapid, large-scale ones (e.g., earthquakes and floods). Even if the abruptness heuristic withstands scrutiny, it cannot distinguish between natural processes and man-made ones.

¹⁶⁵ *Id.* at 31. To be sure, this account is controversial. Collman’s conclusions were based on research conducted by Dennis Avery of the Hudson Institute, Center for Global Food Issues, and Avery’s methods and conclusions have recently been subjected to significant criticism. See, e.g., Marian Burros, *Anti-Organic, and Flawed*, N.Y. TIMES, Feb. 17, 1999, at F5 (challenging Avery’s argument that “organic” chickens bring a higher risk of salmonella, since it relied on a study finding heightened salmonella levels in “premium” chickens, which were not “organic” birds); Nancy Creamer, *CDC Has Never Compared E. Coli Risks of Organic, Traditional Food*, VEG-I-NEWS (N.C. State Univ., Raleigh, N.C.), Feb. 1999, at <http://ipmwww.ncsu.edu/vegetables/veginews/veginw14.htm> (“Contrary to a well-circulated article written by Dennis T. Avery, the [CDC] has never conducted a study that compares the risk of contracting E. coli bacteria in both conventional and organically grown food.”). For Avery’s response to these criticisms, see *Wallace Institute Got It Wrong: CDC Data DOES Indicate Higher Risk from Organic and Natural Foods*, Ctr. for Global Food Issues, Hudson Inst. (Feb. 27, 1999), at http://www.cgfi.org/materials/articles/1999/feb_27_99.htm. In any case, organic foods might be urged on grounds that do not involve human health; perhaps organic farming is less destructive to wildlife and to the environment.

¹⁶⁶ COLLMAN, *supra* note 22, at 199-201; see Tubiana, *supra* note 106, at 12 (“Sun exposure is particularly dangerous for infants and children.”).

¹⁶⁷ Tubiana, *supra* note 106, at 10.

cautionary principle is thought, quite incorrectly, to provide a great deal of analytical help.

C. *The Availability Heuristic*

It is well established that in thinking about risks, people rely on certain heuristics, or rules of thumb, which serve to simplify their inquiry.¹⁶⁸ Of these rules of thumb, the availability heuristic is most important for purposes of understanding the law relating to risks.¹⁶⁹ The availability heuristic also helps illuminate the operation of the precautionary principle, by showing why some hazards will be on-screen and why others will be neglected. For example, “a class whose instances are easily retrieved will appear more numerous than a class of equal frequency whose instances are less retrievable.”¹⁷⁰ Amos Tversky and Daniel Kahneman demonstrate the point with a simple study showing people a list of well-known individuals of both sexes, and asking them whether the list contains more names of women or men. In lists in which the men were especially famous, people thought that the list had more names of men, whereas in lists in which the women were the more famous, people thought that the list had more names of women.¹⁷¹

This is a point about how *familiarity* can affect the availability of instances. A risk that is familiar, like the risk associated with nuclear power, will be seen as more likely than a risk that is less familiar, like the risk associated with heat during the summer.¹⁷² But *salience* is im-

¹⁶⁸ See generally JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES, *supra* note 23 (discussing the rule of heuristics).

¹⁶⁹ See Tversky & Kahneman, *supra* note 23, at 1127-28 (discussing the predictable biases generated by the availability heuristic).

¹⁷⁰ *Id.* at 1127.

¹⁷¹ *Id.*

¹⁷² See generally KLINENBERG, *supra* note 25 (describing the 1995 Chicago heat wave that killed over five hundred people). The availability heuristic might seem in tension with the finding, mentioned above, that familiar risks usually occasion less concern than new and unfamiliar ones. *Supra* text accompanying note 156. But there is no tension. When a risk is familiar in the sense that people can easily think of examples of its occurrence, the estimated probability will be relatively high. This point is not inconsistent with the suggestion that when a risk is new and unfamiliar, people will be especially concerned about it. People often most fear risks that are new and unfamiliar but cognitively accessible: consider the extreme reactions of people in the Washington, D.C., area to the sniper shootings in the fall of 2002. See Cass R. Sunstein, *What's Available? Social Influences and Behavioral Economics*, 97 NW. U. L. REV. (forthcoming Apr. 2003) (manuscript at 2, on file with author) (providing examples of public reactions to the sniper shootings). Of course it is possible that when a risk appears familiar, people will estimate it as relatively high but also show relatively little concern with

portant as well. “For example, the impact of seeing a house burning on the subjective probability of such accidents is probably greater than the impact of reading about a fire in the local paper.”¹⁷³ So too, recent events will have a greater impact than earlier ones. The point helps explain much risk-related behavior, including decisions to take precautions. For example, whether people will buy insurance for natural disasters is greatly affected by recent experiences.¹⁷⁴ If floods have not occurred in the immediate past, people who live on flood plains are far less likely to purchase insurance.¹⁷⁵ In the aftermath of an earthquake, insurance for earthquakes rises sharply—but it declines steadily from that point, as vivid memories recede.¹⁷⁶ Note that the use of the availability heuristic, in these contexts, is hardly irrational.¹⁷⁷ Both insurance and precautionary measures can be expensive, and what has happened before seems, much of the time, to be

that risk—as appears to be the case with driving. These points are best understood by considering the fact that Tversky and Kahneman emphasize familiarity as a way of exploring *estimates of probability*, see Tversky & Kahneman, *supra* note 23, at 1127 (explaining that familiarity affects the retrievability of instances, which leads to predictable biases in estimates of probability), whereas Paul Slovic, Baruch Fischhoff, and Sarah Lichtenstein emphasize familiarity as one of the *qualitative* factors that ordinary people care about when responding to risks, see Slovic et al., *supra* note 156, at 199 (grouping familiarity with observability, knowledge, and immediacy of risk as a family of qualitative factors affecting risk assessment).

¹⁷³ Tversky & Kahneman, *supra* note 23, at 1127.

¹⁷⁴ See Howard Kunreuther, *Limited Knowledge and Insurance Protection*, 24 PUB. POL'Y 227, 250 (1976) (“[A]ny factor which makes the losses from a hazard highly memorable or imaginable—such as a recent disaster or a vivid film—can considerably increase the perceived risk of the event and hence increase the individual’s awareness of its consequences.”).

¹⁷⁵ *Id.* at 248-49.

¹⁷⁶ Paul Slovic et al., *Decision Processes, Rationality, and Adjustment to Natural Hazards*, in NATURAL HAZARDS: LOCAL, NATIONAL, GLOBAL 187, 194 (Gilbert F. White ed., 1974), reprinted in SLOVIC, *supra* note 24, at 1, 14.

¹⁷⁷ Kahneman and Tversky emphasize that the heuristics they identify “are highly economical and usually effective,” but also that they “lead to systematic and predictable errors.” Tversky & Kahneman, *supra* note 23, at 1131. Gerd Gigerenzer, among others, has emphasized that some heuristics can work extremely well. See, e.g., GERD GIGERENZER, ADAPTIVE THINKING: RATIONALITY IN THE REAL WORLD (2000) (applying heuristics of discovery); Gerd Gigerenzer & Peter M. Todd, *Fast and Frugal Heuristics: The Adaptive Toolbox*, in SIMPLE HEURISTICS THAT MAKE US SMART 3, 14 (Gerd Gigerenzer et al. eds., 1999) (explaining that heuristics can be used to solve problems through objects or options). He uses this point as a rejoinder to those who stress the errors introduced by heuristics and biases. For a helpful recent discussion, see Daniel Kahneman & Shane Frederick, *Representativeness Revisited: Attribute Substitution in Intuitive Judgment*, in HEURISTICS AND BIASES: THE PSYCHOLOGY OF INTUITIVE JUDGMENT, *supra* note 127, at 49. I do not mean to take a stand on the resulting debates. Even if many heuristics mostly work well in daily life, a sensible government can do much better than to rely on them.

the best available guide to what will happen again. The problem is that the availability heuristic can lead to serious errors, in terms of both excessive fear and neglect.

The availability heuristic helps to explain the operation of the precautionary principle for a simple reason. Sometimes a certain risk, said to call for precautions, is cognitively available, whereas other risks, including the risks associated with regulation itself, are not. For example, it is easy to see that arsenic is potentially dangerous; arsenic is well known as a poison, forming the first word of a well-known movie about poisoning.¹⁷⁸ By contrast, there is a relatively complex mental operation in the judgment that stringent nuclear power regulation might lead people to use less safe alternatives. In many cases where the precautionary principle seems to offer guidance, the reason is that some of the relevant risks are available while others are barely visible.

It is well known that the availability heuristic affects risk judgments, and we can now appreciate the relationship between that heuristic and the operation of the precautionary principle. But to say the least, the availability heuristic does not operate in a social vacuum.¹⁷⁹ What is readily “available” to some individuals, groups, cultures, and even nations will not be available to all. For example, the risk of nuclear accidents is not so “available” to the French, since that country has not experienced serious health risks from nuclear power even though the country relies heavily on that technology. The lack of saliency partly explains why there has not been a strong movement in France to ban nuclear power.¹⁸⁰ By contrast, the Three Mile Island incident provoked intense concerns about nuclear power plants in the

¹⁷⁸ ARSENIC AND OLD LACE (Warner Bros. 1944).

¹⁷⁹ See Timur Kuran & Cass R. Sunstein, *Availability Cascades and Risk Regulation*, 51 STAN. L. REV. 683, 685 (1999) (arguing that the availability heuristic “interacts with identifiable social mechanisms to generate *availability cascades* . . . through which expressed perceptions trigger chains of individual responses that make these perceptions appear increasingly plausible through their rising availability in public discourse”); Dan Kahan & Donald Braman, *More Statistics, Less Persuasion: A Cultural Theory of Gun-Risk Perceptions*, 151 U. PA. L. REV. (forthcoming Apr. 2003) (manuscript at 23-24, on file with the University of Pennsylvania Law Review) (characterizing the availability heuristic as “relatively weak” in explaining attitudes toward gun control because it fails to consider cultural orientations and, as such, does not explain why the offensive or defensive use of guns “is more ‘available’ to particular individuals”).

¹⁸⁰ See Kuran & Sunstein, *supra* note 179, at 745 (comparing the “popularity and widespread reliance on nuclear power in France [with] its unpopularity and sharply limited use in the United States”).

United States¹⁸¹ and helped promote the widespread idea that a precautionary approach was sensible in order to discourage reliance on nuclear power. Many of those who favor gun control legislation have “available” a set of incidents in which such legislation would have avoided unnecessary deaths; many of those who reject such legislation are alert to incidents in which private gun ownership allowed people to fend off criminal violence.¹⁸² Much remains to be done to clarify the relationship between the availability heuristic and social interactions, including the operations of the media and political officials. For present purposes, the key point is that the availability heuristic often underwrites the use of the precautionary principle, by suggesting the importance of taking precautions against some, but hardly all, of the risks involved.

D. *Probability Neglect*

The availability heuristic can produce an *inaccurate* assessment of probability. But sometimes people will attempt little assessment of probability at all, especially when strong emotions are involved.¹⁸³ In such cases, large-scale variations in probabilities will matter little—even when those variations unquestionably should matter. The point applies to hope as well as fear; vivid images of good outcomes will crowd out consideration of probability too.¹⁸⁴ Lotteries are successful partly for this reason.¹⁸⁵ But for purposes of applying the precautionary principle, the topic is fear rather than hope. I suggest that sometimes the precautionary principle becomes workable because the issue of probability is neglected and people focus on one emotionally gripping outcome among a large set of possibilities.

Probability neglect has received its clearest empirical confirmation in a striking study of people’s willingness to pay to avoid electric

¹⁸¹ See *id.* at 687-88 (noting that environmental organizations gained public support for tighter regulations after the Three Mile Island incident).

¹⁸² See Kahan & Braman, *supra* note 179 (manuscript at 9) (“Control advocates emphasize the risk that insufficient regulation will make citizens vulnerable to deliberate or accidental shootings . . .”).

¹⁸³ See Rottenstreich & Hsee, *supra* note 26, at 186-88 (determining that the weights of small probabilities are higher for affect-rich than affect-poor outcomes).

¹⁸⁴ See *id.* (finding that the weights of small probabilities of affect-rich outcomes like winning a trip to Paris or the opportunity to kiss a movie star are greater than their cash values).

¹⁸⁵ See PHILLIP COOK, *SELLING HOPE* 71 (1993) (explaining that lottery players do not approach objective odds in the same way that statisticians do).

shocks.¹⁸⁶ The central purpose of the study was to test the relevance of probability in “affect-rich” decisions. One experiment investigated whether varying the probability of harm would matter more, or less, in settings that trigger strong emotions than in settings that seem relatively emotion free. In the “strong emotion” setting, participants were asked to imagine that they would participate in an experiment involving some chance of a “short, painful, but not dangerous electric shock.”¹⁸⁷ In the relatively emotion-free setting, participants were told that the experiment entailed some chance of a \$20 penalty.¹⁸⁸ Participants were asked to state how much they would be willing to pay to avoid participating in the relevant experiment. Some participants were told that there was a 1% chance of receiving the bad outcome (either the \$20 loss or the electric shock); others were told that the chance was 99%; and still others were told that the chance was 100%.¹⁸⁹

The key result was that variations in probability affected those facing the relatively emotion-free injury, the \$20 penalty, far more than they affected people facing the more emotionally evocative outcome of an electric shock.¹⁹⁰ For the cash penalty, the difference between the median payment for a 1% chance and the median payment for a 99% chance was predictably large and indeed consistent with the standard model: \$1 to avoid a 1% chance, and \$18 to avoid a 99% chance.¹⁹¹ For the electric shock, by contrast, the difference in probability made little difference to median willingness to pay: \$7 to avoid a 1% chance, and \$10 to avoid a 99% chance!¹⁹² Apparently people will pay a significant amount to avoid a small probability of a hazard that is affectively laden—and the amount that they will pay will not vary greatly with changes in probability. This point explains “why societal concerns about hazards such as nuclear power and exposure to extremely small amounts of toxic chemicals fail to recede in response to information about the very small probabilities of the feared consequences from such hazards.”¹⁹³

¹⁸⁶ Rottenstreich & Hsee, *supra* note 26, at 185-90.

¹⁸⁷ *Id.* at 188.

¹⁸⁸ *Id.*

¹⁸⁹ *Id.*

¹⁹⁰ *Id.*

¹⁹¹ *Id.*

¹⁹² *Id.*

¹⁹³ Paul Slovic et al., *The Affect Heuristic*, in *HEURISTICS AND BIASES: THE PSYCHOLOGY OF INTUITIVE JUDGMENT*, *supra* note 127, at 397, 409.

It should be easy to understand the connection between probability neglect and the precautionary principle. If probabilities are neglected, especially when emotions are engaged, then the principle will operate through excessive public concern with certain low-probability hazards. Return to the contrast between deaths from heat waves and deaths from airplane crashes. The latter trigger far more intense public attention, in part because of the availability heuristic, but in part because for some people the outcome itself has such salience and the probability much less so. In the context of genetic modification of food and global warming, the same phenomenon is at work, leading people to think that the precautionary principle, simply applied, calls for aggressive regulatory controls. Note that I am not urging that such controls are a mistake; in the context of global warming, they seem to be warranted by the facts. My claim is only that the precautionary principle appears to give guidance in part because the issue of probability is neglected.

For purposes of understanding the operation of the precautionary principle, it is important to see that visualization, or imagery, matters a great deal to people's reactions to risks.¹⁹⁴ When an image of a bad outcome is easily accessible, people will become greatly concerned about a risk, holding probability constant.¹⁹⁵ Consider the fact that when people are asked how much they will pay for flight insurance for losses resulting from "terrorism," their responses indicate they will pay more than if they are asked how much they will pay for flight insurance from all causes.¹⁹⁶ The evident explanation for this peculiar result is that the word "terrorism" evokes vivid images of disaster, thus crowding out probability judgments. Note also that when people discuss a low-probability risk, their concern rises even if the discussion consists mostly of apparently trustworthy assurances that the likeli-

¹⁹⁴ See Paul Slovic et al., *Violence Risk Assessment and Risk Communication: The Effects of Using Actual Cases, Providing Instruction, and Employing Probability Versus Frequency Formats*, 24 *LAW & HUM. BEHAV.* 271, 289-94 (2000) (discussing the experimental effect on risk judgments and information format).

¹⁹⁵ See George F. Loewenstein et al., *Risk as Feelings*, 127 *PSYCHOL. BULL.* 267, 275-76 (2001) (noting the effects of vividness on emotional responses to risk and stating that "people tend to be underinsured against hazards that evoke relatively pallid mental images").

¹⁹⁶ See Eric J. Johnson et al., *Framing, Probability Distortions, and Insurance Decisions*, 7 *J. RISK & UNCERTAINTY* 35, 40-42 (1993) (describing test results that reflect bias in favor of "terrorism" coverage over total coverage, even where total coverage included insurance against terrorist acts).

hood of harm really is infinitesimal.¹⁹⁷ The reason is that the discussion makes it easier to visualize the risk and hence to fear it.

An experiment of my own, involving people's willingness to pay for reductions in arsenic in drinking water,¹⁹⁸ points in the same direction. When cancer deaths from arsenic were described in emotionally gripping terms, people's willingness to pay for reductions substantially increased.¹⁹⁹ More directly to the point, a substantial variation in the probability of death (from one in one million to one in 100,000) had more effect on willingness to pay in the unemotional condition than in the emotional condition.²⁰⁰ The basic finding, then, is that when the bad outcome is emotionally gripping, people are more likely to neglect differences in probability than when the bad outcome is emotionally neutral.

Probability neglect does not involve the availability heuristic. That heuristic does not lead people to neglect probability but to *answer* the question of probability by substituting a hard question (what is the statistical risk?) with an easy question (do salient examples readily come to mind?).²⁰¹ My point here is not that visualization makes an event seem more probable (though this is also true), but that visualization makes the issue of probability less relevant or even irrelevant. In theory, the distinction between use of the availability heuristic and probability neglect should not be obscure. In practice, of course, it will often be hard to know whether the availability heuristic or probability neglect is driving behavior.

The most sensible conclusion is that, with respect to risks of harm, vivid images and concrete pictures of disaster can "crowd out" other kinds of thoughts, including the crucial thought that the probability of disaster is really small. "If someone is predisposed to be worried, degrees of unlikeliness seem to provide no comfort, unless one can

¹⁹⁷ See Ali Siddiq Alhakami & Paul Slovic, *A Psychological Study of the Inverse Relationship Between Perceived Risk and Perceived Benefit*, 14 RISK ANALYSIS 1085, 1095 (1994) (stating that "[a] person's general affective evaluation of the item was the major predictor of risk/benefit correlation" and that "[s]ome items showed strong negative [evaluations] but relatively low [risk]").

¹⁹⁸ Cass R. Sunstein, *Probability Neglect: Emotions, Worst Cases, and the Law*, 112 YALE L.J. 61, 77-80 (2002).

¹⁹⁹ *Id.* at 78-79.

²⁰⁰ *Id.* at 79.

²⁰¹ See Amos Tversky & Daniel Kahneman, *Availability: A Heuristic for Judging Frequency and Probability*, 5 COGNITIVE PSYCHOL. 207, 227-30 (1973) (urging that people make risk assessments by trying to remember if something has occurred in the past and assigning the probability based on the difficulty of recall).

prove that harm is absolutely impossible, which itself is not possible.²⁰² Probability neglect, I suggest, often makes the precautionary principle seem sensible and workable. Indeed, the precautionary principle often embodies a form of probability neglect. When people focus on highly speculative risks associated with certain risks, it is often because of intense emotional reactions that make those risks, and not relevant others, stand out from the background. In many cases, probability neglect and loss aversion march hand-in-hand. Potential losses from the status quo often trigger intense emotions, whereas potential gains do not; and when the precautionary principle is operating, the low-probability losses have far more salience than they deserve.²⁰³

Nor is the problem of probability neglect foreign to law. In many contexts, law seems to be a response, in part, to fear of bad outcomes without close attention to the question of probability—along one dimension, the precautionary principle in action.²⁰⁴ Reconsider the European Community's ban on meat products treated with hormones, which has raised large-scale issues about the role of public fears in risk regulation.²⁰⁵ The Appellate Body of the World Trade Organization (WTO) ruled that the ban ran afoul of Article 5.1 of the Agreement on Sanitary and Phytosanitary Measures,²⁰⁶ which requires members of the WTO to justify all health and safety regulations by reference to scientific risk assessments.²⁰⁷ In this way, the Appellate Body rejected the European Community's effort to defend itself by pointing to con-

²⁰² JOHN WEINGART, WASTE IS A TERRIBLE THING TO MIND: RISK, RADIATION, AND DISTRUST OF GOVERNMENT 362 (2001).

²⁰³ With respect to global warming, this is the suggestion in GOKLANY, *supra* note 3, at 57-88; LOMBORG, *supra* note 67, at 258-326.

²⁰⁴ See Sunstein, *supra* note 198, at 87-90 (describing how OSHA and EPA have failed on occasion to consider probability of harm).

²⁰⁵ For an illuminating discussion concerning the role of regulators in responding to public fears that are disproportionate to the risks, see Howard F. Chang, Risk Regulation, Public Concerns, and the Hormones Dispute: Nothing to Fear but Fear Itself? (Feb. 18, 2003) (unpublished manuscript, on file with author).

²⁰⁶ EC Measures Concerning Meat and Meat Products (Hormones): Report of the Appellate Body, Jan. 16, 1998, No. 98-0099, para. 208, available at <http://www.wto.org>.

²⁰⁷ See Agreement on the Application of Sanitary and Phytosanitary Measures, Apr. 15, 1994, art. 5.1, Marrakesh Agreement Establishing the World Trade Organization, Annex 1A, LEGAL INSTRUMENTS—RESULTS OF THE URUGUAY ROUND vol. 27, 33 I.L.M. 1125 (1994) ("Members shall ensure that their sanitary or phytosanitary measures are based on an assessment, as appropriate to the circumstances, of the risks to human, animal or plant life or health, taking into account risk assessment techniques developed by the relevant international organizations.").

sumer fears about the safety of beef treated with hormones.²⁰⁸ In this context, such fears were apparently real, but they neglected the issue of probability.²⁰⁹ Scientific evidence was a prerequisite for regulations.

E. *System Neglect*

The fifth point is, in a way, the largest. My suggestion is that, much of the time, people neglect the systemic effect of one-shot interventions. They tend to assume that a change in a social situation will alter the part at issue, but without altering other parts. System neglect, thus understood, includes the general phenomenon of tradeoff neglect, by which people fail to see the frequent need to weigh competing variables against one another.²¹⁰ But tradeoff neglect is only part of what is involved here. When the precautionary principle gives guidance, and when it goes wrong, it is often because those who use it are falling victim to system neglect.

The clearest evidence comes from the German psychologist Dietrich Dörner, who has designed some fascinating experiments to see whether people can reduce social risks.²¹¹ Dörner's experiments are run via computer. Participants are asked to reduce risks faced by the inhabitants of some region of the world. The risks may involve pollution, poverty, poor medical care, inadequate fertilization of crops, sick cattle, insufficient water, or excessive hunting and fishing. Through the magic of the computer, many policy initiatives are available (e.g., improved care of cattle, childhood immunization, and drilling more wells). Participants are able to choose among them. Once

²⁰⁸ See Michele D. Carter, *Selling Science Under the SPS Agreement: Accommodating Consumer Preference in the Growth Hormones Controversy*, 6 MINN. J. GLOBAL TRADE 625, 627 (1997) ("In citing consumer anxiety over the safety of beef treated with hormones, the European Community implicitly equated consumer fears over hormone safety with actual public health needs." (footnote omitted)).

²⁰⁹ For a discussion of the complex normative issues, see Chang, *supra* note 205.

²¹⁰ See MARGOLIS, *supra* note 30, at 2 (discussing tradeoff neglect). In fact it would be possible to see many people as suffering from *gain neglect*, because they downplay the potential gains associated with certain activities or usage. If opportunity costs are valued less than out-of-pocket costs, gain neglect might be part of the reason. The same might be said of those who emphasize the risks associated with genetic modification of food, but downplay the "opportunity benefits" forgone as a result of regulation. Gain neglect is of course another way of describing loss aversion, discussed *supra* Part III.A. I suggest that the well-understood idea of loss aversion is actually an exercise in framing, and that "gain neglect" might be an equally apt, or even more apt, description of what has been found.

²¹¹ DÖRNER, *supra* note 28.

particular initiatives are chosen, the computer projects, over short periods and then over decades, what is likely to happen in the region.

In these experiments, success is entirely possible. Some initiatives will actually make for effective and enduring improvements. But many of the participants—even the most educated and professional—produce calamities. They do so because they fixate on isolated problems and do not see the complex, system-wide effects of particular interventions. For example, they may appreciate the importance of increasing the number of cattle, but once they do that, they create a serious risk of overgrazing, which they failed to anticipate.²¹² They may appreciate the value of drilling more wells to provide water, but they do not anticipate the energy and environmental effects of the drilling, which then endangers the food supply. Only the rare participant is able to see a number of steps down the road—to understand the multiple effects of one-shot interventions into the system and to assess a wide range of consequences from those interventions. The successful participants seem to take small, reversible steps, or to see the full set of effects at once, and thus to protect themselves against major blunders. When people are not successful, it is because they fail to see that risks are parts of systems.²¹³

How would the precautionary principle operate if invoked in Dörner's experiments? It should be easy to see that while the weaker versions might provide some assistance, the stronger versions offer no help at all. There are simply too many risks against which one might take precautions. Precautions cannot be taken against all risks, not for the important but less interesting reason that resources are limited, but simply because efforts to redress any set of risks might produce risks of their own. The real world of risk regulation offers many analogues.²¹⁴ To the extent that the precautionary principle appears to offer guidance, it is often because adverse systemic effects, and the need to take precautions against them, are simply being neglected.

Howard Margolis has used a related point to explain why experts have different risk judgments from ordinary people, and he has done

²¹² *See id.* at 5-10 (arguing that human beings' tendencies to deal with problems on an "ad hoc basis" fail to account for the risk inherent in any complex system and considering various explanations for that incapacity).

²¹³ For some real-world analogues to Dörner's experiments, see JAMES C. SCOTT, *SEEING LIKE A STATE: HOW CERTAIN SCHEMES TO IMPROVE THE HUMAN CONDITION HAVE FAILED* (1998).

²¹⁴ *See* Wiener, *supra* note 3, at 1521-26 (discussing the multirisk nature of social situations).

so in a particular effort to explain why and when ordinary people will think, “better safe than sorry.”²¹⁵ Margolis thus offers some cognitive foundations for the precautionary principle without explicitly discussing the idea. Margolis’s goal is to cast light on some apparent anomalies in ordinary thinking about risks: Why do people believe that small risks from pesticides should be regulated, if comparatively small risks from X-rays are quite tolerable? Why are people so concerned about the risks of nuclear power, when experts tend to believe that the risks are quite low—lower, in fact, than the risks from competing energy sources, such as coal-fired power plants, which produce less public objection?

Margolis suggests that people are sometimes subject to a kind of optical illusion, in which they see the harms associated with some activity or process, but fail to appreciate the benefits. If so, they will tend to think, “better safe than sorry.”²¹⁶ If they perceive both, they will see some “fungibility” between both harms and benefits and engage in the kind of tradeoff analysis that is more typical for experts.²¹⁷ Margolis offers a nice example to support this suggestion.²¹⁸ The removal of asbestos from schools in New York City was initially quite popular, indeed demanded by parents, even though experts believed that the risks were statistically small.²¹⁹ (As it happens, the risk of a child getting cancer from asbestos insulation was about one-third the risk of being struck by lightning.)²²⁰ But when it emerged that the removal would cause schools to be closed for a period of weeks, and when the closing caused parents to become greatly inconvenienced, parental attitudes turned right around, and asbestos removal seemed like a really bad idea.²²¹ When the costs of the removal came on-screen, parents thought much more like experts, and the risks of asbestos seemed well worth tolerating: statistically small, and on balance worth incurring. The precautionary principle often operates because

²¹⁵ See MARGOLIS, *supra* note 30, at 75 (explaining that the risk matrix is an attempt to provide an account of why some people are blind to a “waste not, want not” position, while fully embracing the polar-opposite state of “better safe than sorry”).

²¹⁶ See *id.* at 75-81 (explaining the “better safe than sorry” and “waste not” positions in terms of the risk matrix).

²¹⁷ See *id.* at 75-92 (describing the differences in expert and lay assessments of risk in terms of the risk matrix).

²¹⁸ See *id.* at 124-28 (setting forth the facts of the 1993 New York City school asbestos closings).

²¹⁹ *Id.* at 124.

²²⁰ Tony Snow, *End the Phony “Asbestos Panic,”* USA TODAY, Sept. 13, 1993, at 11A.

²²¹ MARGOLIS, *supra* note 30, at 124-25.

of the visibility of only one side of the ledger, just as parents, in advance of asbestos removal, see the possibility of the hazard without confronting the problems introduced by reducing it.

For an especially vivid example, consider the apparent views of Americans in the late 1990s. About sixty-three percent of Americans agreed with the statement, "Protecting the environment is so important that requirements and standards cannot be too high and continuing environmental improvements must be made regardless of cost."²²² In the same general vein, fifty-nine percent supported the Kyoto Treaty on global warming, with only twenty-one percent opposed.²²³ But in the same period, fifty-two percent of Americans said they would refuse to support the Kyoto Treaty if "it would cost an extra \$50 a month for an average American household."²²⁴ In fact, only eleven percent of Americans would support the Kyoto Treaty if the monthly expense were \$100 or more.²²⁵ How can we explain strong majority support for "environmental improvements . . . regardless of cost" and strong majority rejection of environmental improvements when the cost is high? The answer lies in the fact that people are not, in fact, willing to spend an infinite amount for environmental improvements, and that unless the costs are squarely placed "on-screen," people's weighing might be insufficiently reflective.²²⁶

There are many other examples. People seem quite concerned about the risks associated with dioxin, a real candidate for use of the precautionary principle, but far less concerned about the statistically equivalent risks associated with aflatoxin, a carcinogen found in peanut butter.²²⁷ When aflatoxin does not trigger public concern, a large part of the reason is that the burdens of banning aflatoxin seem high and indeed intolerable; too many people would object to heavy regulation of peanut butter, for generations a staple of school lunches and many diets. In this light, it is both mildly counterintuitive and reasonable, for example, to predict that people would be willing to pay *less*, in terms of dollars and waiting time, to reduce low-probability risks of

²²² *Americans on the Global Warming Treaty*, *supra* note 55, at http://www.pipa.org/OnlineReports/GlobalWarming/glob_warm_treaty.html.

²²³ *Id.*

²²⁴ *Id.*

²²⁵ *Id.*

²²⁶ I am not suggesting that such weighing should be decisive for purposes of policy. For one thing, it might not be sufficiently reflective even if tradeoffs are considered. For another, the interests of animals should count whether or not they are included in conventional cost-benefit balancing.

²²⁷ MARGOLIS, *supra* note 30, at 136-37.

an airplane disaster if they are frequent travelers. An intriguing study finds exactly that effect.²²⁸ It is also safe to predict that if people were told, by a reliable source, that eliminating pesticides would lead to serious health problems—for example, because pesticide-free fruits and vegetables carried special dangers—the perceived risk of pesticides would decline dramatically, and it would be difficult to invoke the precautionary principle as a basis for stringent regulation of pesticides.²²⁹ Indeed, I predict that if people were informed that eliminating pesticides would lead to a significant increase in the price of apples and oranges, the perceived risk would go down as well.²³⁰

How might ideas operate in practice? Consider an example: The precautionary principle should not be applied, in its most aggressive form, to the general category of “pesticides.” An approach of this sort, banning many or most pesticides, would produce substantial risks of its own, partly because pesticides reduce some risks, partly because some substitutes for pesticides produce risks of their own. It would be far more sensible to adopt a precautionary approach to those pesticides that appear, on the basis of existing evidence, to create a significant risk of harm, even if that risk cannot be proved beyond a reasonable doubt. This is the weak version of the precautionary principle, which, I have urged, should be seen as unexceptionable. But even if significant risks can be found, it is also important to identify the risks associated with the substitutes for those pesticides, and to know whether those risks are also to be controlled if they are significant. After assessing the relevant risks, it remains to consider the economic costs of restrictions, as indeed existing law requires,²³¹ in recognition

²²⁸ See Mathew Harrington, *People’s Willingness to Accept Airport Security Delays in Exchange for Lesser Risk 6-7* (Jan. 28, 2002) (unpublished manuscript, on file with author) (describing how the twelve survey respondents who had experienced significant delays were less willing to pay for additional airport security than those twenty-four respondents who had not experienced such delays).

²²⁹ See Carolyn Raffensperger, *The Precautionary Principle as Forecaring: Hopeful Work for the Environmental Health Movement, Remarks at the Mount Alverno Conference Center* (Oct. 6-8, 2000) (arguing that the precautionary principle often requires regulation of pesticides), available at <http://www.biotech-info.net/forecaring.html>.

²³⁰ For evidence of this general phenomenon, see Melissa L. Finucane et al., *The Affect Heuristic in Judgments of Risks and Benefits*, 13 J. BEHAV. DECISION MAKING 1, 9-13 (2000), reprinted in SLOVIC, *supra* note 24, at 413, 421-26.

²³¹ See 7 U.S.C. § 136(bb) (2000) (defining unreasonable adverse effects on the environment to include “any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide”). Note in this regard one study’s finding that a ban on certain widely used pesticides would increase household retail food prices by only \$5.90-\$8.60 per year.

of the need for a wider viewscreen than that afforded by the precautionary principle.

The conclusion is that the precautionary principle often seems helpful because analysts focus on the “target” risk and not on the systemic, risk-related effects of being precautionary, or even on the risk-related consequences of risk reduction. Rational regulators, of course, think about systems, not snapshots.²³² And once we see that risks are inevitably part of systems, the precautionary principle will become far less helpful.

IV. TOWARD WIDER VIEWSCREENS

In this Article, I have argued not that the precautionary principle leads in the wrong directions, but that if it is taken for all that it is worth, it leads in no direction at all. The reason is that risks of one kind or another are on all sides of regulatory choices, and it is therefore impossible, in most real-world cases, to avoid running afoul of the principle. Frequently, risk regulation creates a (speculative) risk from substitute risks or from forgone risk-reduction opportunities. And because of the (speculative) mortality and morbidity effects of costly regulation, any regulation, if it is costly, threatens to run afoul of the precautionary principle. We have seen that both regulation and non-regulation seem to be forbidden in cases involving nuclear power, arsenic, global warming, and genetic modification of food. The precautionary principle appears to offer guidance only because people blind

RONALD D. KNUTSON & EDWARD G. SMITH, IMPACTS OF ELIMINATING ORGANOPHOSPHATES AND CARBAMATES FROM CROP PRODUCTION 112-13 (Agric. & Food Policy Ctr., Policy Working Paper No. 99-2, 1999), available at <http://www.afpc.tamu.edu/pubs/0/114/wp99-2.pdf>. Of course, I do not mean to endorse that controversial finding here.

²³² There might seem to be some tension between the plea for wide viewscreens and my (qualified) argument for a form of judicial minimalism in CASS R. SUNSTEIN, ONE CASE AT A TIME (1999). But there is no tension. Minimalism is a form of incrementalism, arguing on behalf of “small steps” in part because of the risk that large-scale interventions into systems will have unanticipated adverse consequences. *See id.* at 53 (“Within the judiciary, minimalism is a sensible reaction to the limitations that judges know they face, not least in predicting the consequences of their decisions.”). Indeed, Dörner himself suggests that small steps are a desirable approach to the risk of system neglect. DÖRNER, *supra* note 28, at 166-81; *see id.* at 2 (“[H]uman planning and decision-making processes can go awry . . . if we apply corrective measures too aggressively or too timidly . . .”). By endorsing a wide viewscreen, I do not mean to challenge small steps, but instead to urge that in taking any step at all, officials should look at the range of likely consequences. Of course it is possible that a full assessment of such consequences will be beyond existing capacities. In such cases, simplifying devices might be helpful. *See* GOKLANY, *supra* note 3, at 9-10, for some suggestions.

themselves to certain aspects of the risk situation, focusing on a mere subset of the hazards that are at stake.

To some extent, those who endorse the precautionary principle are responding to salutary political or moral motivations that the principle might be thought to embody. Well-organized private groups sometimes demand conclusive proof of harm as a precondition for regulation; the demand should be firmly resisted because a probability of harm is, under many circumstances, a sufficient reason to act. Both individuals and societies have a tendency to neglect the future; the precautionary principle might be understood as a warning against that form of neglect. There are extremely good reasons to incorporate distributional considerations into risk regulation, and the precautionary principle seems, some of the time, to be a way to protect the most disadvantaged against risks of illness, accident, and death. Sometimes people try to reduce dissonance by thinking that actual risks are trivial; the precautionary principle might be a helpful counterweight to this mechanism. The problem is that the precautionary principle, as applied, is a crude and sometimes perverse way to promote these various goals, not least because it might be, and has been, urged in situations in which the principle threatens to injure future generations and to harm rather than to help those who are most disadvantaged.

I have also urged that the precautionary principle can be made operational only because of identifiable cognitive mechanisms. Often loss aversion is at work. The benefits of certain practices are less salient than the costs, simply because the costs would, along an important dimension, represent a deterioration from the status quo. When loss aversion is involved, it might be thought, wrongly, that natural processes are always safer and better for the environment than processes that involve human intervention. Sometimes the precautionary principle works by exploiting the availability heuristic, because the risks that matter are cognitively accessible, whereas the risks that are ignored are far less so. Frequently the precautionary principle is underwritten by probability neglect. Highly speculative harms are emphasized by those who focus on the badness of the relevant outcomes, rather than the likelihood that they will occur. Most generally, the precautionary principle sometimes gives an illusion of guidance because people focus on the immediate risk while disregarding the systemic effects of one-shot interventions, even though those interventions can give rise to risks of their own.

I have not suggested any particular substitute for the precautionary principle. But I do not endorse the suggestion of Aaron Wildav-

sky, a political scientist with a special interest in risk regulation, who also rejects the precautionary principle.²³³ In Wildavsky's view, the notion of "precaution" should be abandoned and replaced with a principle of "resilience," based on an understanding that nature and society are quite able to incorporate even strong shocks, and that the ultimate dangers are therefore smaller than we are likely to fear.²³⁴ It would follow from the "resilience" principle that a nation should be less concerned than it now is with the risks associated with (for example) arsenic, global warming, and destruction of the ozone layer. Unfortunately, the principle of "resilience" is no better than that of "precaution." Some systems are resilient, but many are not. Whether an ecosystem, or a society, is "resilient" cannot be decided in the abstract. In any case, resilience is a matter of degree. Everything depends on the facts. The "resilience principle" should be understood as a heuristic, one that favors inaction in the face of possibly damaging technological change. Like most heuristics, the resilience principle will work well in many circumstances, but it can also lead to systematic and even deadly errors.²³⁵

A better approach would acknowledge that a wide variety of adverse effects may come from inaction, regulation, and everything in between. Such an approach would attempt to consider all of those adverse effects and not simply a subset.²³⁶ When existing knowledge does not allow clear assessments of the full range of adverse effects, such an approach would develop simplifying devices, helping to show the appropriate course of action in the face of uncertainty.²³⁷ Such an

²³³ See WILDAVSKY, *supra* note 138, at 430-33 (criticizing the use of the precautionary principle in the environmental health and safety context).

²³⁴ *Id.* at 433.

²³⁵ See Tversky & Kahneman, *supra* note 23 (illustrating how heuristics can lead to systematic mistakes). The "resilience" principle might well be taken as a reflection of optimistic bias. See TAYLOR, *supra* note 127, at 6 ("[S]ocial scientists have found that rather than perceiving themselves, the world, and the future accurately, most people regard themselves, their circumstances, and the future as considerably more positive than is objectively likely or than reality can sustain."); Neil D. Weinstein, *Unrealistic Optimism About Future Life Events*, 39 J. PERSONALITY & SOC. PSYCHOL. 806, 819 (1980) (hypothesizing that those with unrealistic optimism "may be inclined to engage in risky behaviors and to ignore precautions").

²³⁶ See SUNSTEIN, *supra* note 45, at 43-60 (describing health-health analysis, which evaluates the benefits of a regulation against the costs of complying with it); Wiener, *supra* note 3, at 1509-26 (examining precaution in a world of multiple risks).

²³⁷ See GOKLANY, *supra* note 3, at 9-10, for a discussion of these devices. Instead of advocating full-fledged balancing of relevant variables, Goklany proposes that regulators look at a list of criteria, including the "human mortality criterion" (valuing human life over that of members of other species), the "immediacy criterion" (giving priority

approach would pursue distributional goals directly by, for example, requiring wealthy countries, major contributors to the problem of global warming, to pay poor countries to reduce greenhouse gases or to prepare themselves for the relevant risks. Such an approach would attempt to counteract, rather than to embody, the various cognitive limitations that people face in thinking about risks. An appreciation of the difficulties with the precautionary principle suggests the importance of overcoming cognitive limitations by ensuring that people have a full, rather than limited, sense of what is at stake. The result should be to help with cognitive distortions and to produce sensible priority-setting. An effort to produce a fair accounting of the universe of dangers should also help to diminish the danger of interest-group manipulation.

To be sure, public alarm, even if ill-informed, is itself a harm, and it is likely to lead to additional harms, perhaps in the form of large-scale “ripple effects.”²³⁸ A sensible approach to risk will attempt to reduce public fear even if it is baseless. My goal here has been not to deny that point, but to explain the otherwise puzzling appeal of the precautionary principle and to isolate the strategies that help make it operational. At the individual level, these strategies are hardly senseless, especially for people who lack much information or who do the best they can by focusing on only one aspect of the situation at hand.²³⁹ But for governments, the precautionary principle is not sensible, for the simple reason that once the viewscreen is widened, it becomes clear that the principle provides no guidance at all. A rational

to immediate threats), the “uncertainty criterion” (giving priority to risks with a higher probability of occurring), and “the irreversibility criterion” (giving priority to risks that are likely to be permanent or persistent). *Id.* Some of these criteria seem doubtful to me; a less immediate threat might, for example, deserve priority if its magnitude so suggests, and it is unclear that a small number of human lives deserve priority over a large number of lives of members of other species. But Goklany is correct to seek an approach that helps in making decisions under uncertainty.

Wiener, *supra* note 3, at 1520, also offers some valuable suggestions, involving in particular the need to ensure “risk-superior moves,” meaning approaches that reduce overall risks. As Wiener is aware, the problem with this approach is that sometimes we will lack sufficient information to identify such moves, because regulation must proceed in the face of uncertainty rather than risk.

²³⁸ See the discussion of the social amplification of risk through ripple effects in Roger E. Kasperson et al., *The Social Amplification of Risk: A Conceptual Framework*, 8 RISK ANALYSIS 177, 183-84 (1988).

²³⁹ See Gigerenzer & Todd, *supra* note 177, at 3-5 (urging that “fast and frugal decision-making [based on heuristics] can be as accurate as strategies that use all available information and expensive computation”).

system of risk regulation certainly takes precautions. But it does not adopt the precautionary principle.