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Acts of God or Toxic Torts - Applying Tort Principles to the Problem of Climate Change

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ABSTRACT

The problem of climate change continues to be an intractable one for policymakers. Uncertainties over the likely costs of climate change as well as over the costs of proposed remedies have hampered the formation of a consensus regarding the best course of action. The principles of tort law provide a useful means of analyzing the problem of climate change, particularly the issue of who should bear the costs associated with its effects. The two major goals of tort law (reducing the costs of accidents and corrective justice) both point towards the appropriateness of placing the costs of climate change on those who manufacture fossil fuels. Several obstacles, particularly issues of causation, stand in the way of a tort analysis of climate change. These obstacles can be overcome through a philosophically sound approach to the issue of causation and the adoption of a system of proportional liability.

I. INTRODUCTION

No environmental problem looms larger than the threat of global climate change. In terms of sheer scale, the harm it portends dwarfs almost all other environmental concerns. Despite the enormous havoc that may ensue from climatic disruptions caused by the unchecked build-up of "greenhouse gases" in the atmosphere, policymakers have proven to be incapable of reaching any consensus on the appropriate action to reduce emissions.[1] Although in 1992 the United States pledged to stabilize its emissions at 1990 levels by the year 2000, its CO_2 emissions have continued to increase steadily.[2]

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1. *See, e.g.*, John H. Cushman Jr., *Intense Lobbying Against Global Warming Treaty*, N.Y. TIMES, Dec. 7, 1997, at A28 (describing lobbying by "powerful business interests" against any mandatory reductions in greenhouse emissions); John H. Cushman Jr. & David E. Sanger, *No Simple Fight: The Forces that Shaped the Clinton Plan*, N.Y. TIMES, Dec. 1, 1997, at GW3 (describing the conflict-ridden evolution of President Clinton's proposed U.S. position for the December 1997 Kyoto conference).

2. *See* John H. Cushman Jr., *U.S. Says Its Greenhouse Gas Emissions Are at Highest Rate in Years*, N.Y. TIMES, Oct. 21, 1997, at A22.

The United States and the international community have considered several policy responses. Voluntary reductions, carbon taxes, emissions trading, and government subsidies to alternative energy have all been proposed as means of reducing greenhouse gas emissions, with none of them gaining widespread support.[3] Uncertainty over the costs of global climate change and of the policies proposed to halt it, as well as strong opposition from wealthy oil companies, have impeded the formulation of a viable climate-change policy.[4]

This article argues that an analysis based on the model of tort liability can contribute to the ongoing debate over the proper policy response to climate change. By exploring the issue of anthropogenic climate change in terms of the allocation of accident costs and corrective justice, two concepts at the heart of tort law, it attempts to point toward one possible way out of the current political deadlock.[5] Although these concepts have been particularly salient with American tort law, and are thus perhaps most helpful when considering the shape of climate change policies within the United States, they also present a useful method of analysis that could be extended to international solutions as well.

Part II briefly explores the basic science of climate change, emphasizing three features of the problem: (1) the strong link between carbon dioxide (CO_2) and climate change; (2) the locally uneven effects of climatic disruptions; and (3) the uncertainties in our current understanding. Part III argues that the features of climate change make tort law an appropriate framework for developing a policy response. In particular, I discuss climate change in relation to two major goals of tort law: reduction of accident costs and corrective justice. Part IV addresses some of the obstacles to a tort approach to climate change: establishing causation, calculating the proper remedies, and choosing a structure for implementing a tort-based approach. The greatest of these problems is that of causation. Many of the causation problems, however, result from tort law's stubborn adherence to an outmoded, mechanistic understanding of causation. A sound approach to causation, one based upon a statistical probability,

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3. *See* William K. Stevens, *Doubts on Cost Are Bedeviling Climate Policy*, N.Y. TIMES, Oct. 6, 1997, at A16.

4. *See id. See also Industry Battles Clinton on Climate*, UPI, Sept. 10, 1997 (describing a $13 million industry campaign to prevent the United States from endorsing steep reductions in CO_2 emissions).

5. Please note that I am not suggesting that a tort approach can be a complete solution to the problem of climate change. It might, however, represent a first step toward a comprehensive climate change policy involving a whole range of actions to combat CO_2 emissions. In any event, many other tools are necessarily involved in solving the problem of climate change. I merely suggest that a policy modeled after tort liability is one of those tools, one that has been neglected by policymakers to date.

would substantially reduce these difficulties. Finally, in Part V, the article concludes by discussing how a tort-based policy could work in conjunction with a carbon tax to reduce greenhouse gas emissions.

II. THE SCIENCE OF CLIMATE CHANGE

This part discusses the current state of scientific knowledge on the problem of climate change. Its goal is not to present a comprehensive analysis of the voluminous literature on this subject.[6] Instead, it seeks simply to provide a brief outline of the factual assumptions upon which my analysis is based. Much of the information in this paper derives from *Climate Change 1995*,[7] a report produced by the Intergovernmental Panel on Climate Change (IPCC), a committee created by the United Nations in 1988 to assess the scientific data on global climate change and its likely effects.[8]

A. The Causes of Climate Change

Although there is debate over whether or not climate change is already taking place, there is a growing consensus among scientists that the first signs of human effects on the global climate are starting to appear.[9] The IPCC has concluded, "the balance of evidence suggests that there is a discernible human influence on global climate."[10] This paper assumes that the first signs of global climate change are beginning to emerge and are likely to grow more serious if not addressed in the near future.[11]

Put simply, anthropogenic climate change—as distinguished from the natural variability of the earth's climate[12]—results from the release of greenhouse gases into the atmosphere. Greenhouse gases impede the escape of infrared radiation from the Earth into space, causing a net

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6. For such a comprehensive overview, see CLIMATE CHANGE 1995: THE SCIENCE OF CLIMATE CHANGE (J.T. Houghton et al. eds., 1996) [hereinafter CLIMATE CHANGE 1995].

7. For a skeptical account of the climate change problems, see ROBERT C. BALLING, THE HEATED DEBATE: GREENHOUSE PREDICTIONS VS. CLIMATE REALITY (1992). Balling's work has been harshly criticized by Ross Gelbspan, who accuses him of being a pawn of the oil industry. *See* Ross Gelbspan, *Disinformation on Global Warming Interests*, SACRAMENTO BEE, July 13, 1997, at Forum 1. Gelbspan discloses that Balling has received "nearly $300,000 from coal and oil interests in research funding." *Id.* Climate Change 1995.

8. *See* CLIMATE CHANGE 1995, at vii.

9. *See id.* at 5.

10. *Id.*

11. *See id.*

12. Natural variability in the earth's climate may be due to such factors as variations in the sun's radiation and in the earth's orbit, volcanic eruptions, and "complex interactions between components of the climate system such as the atmosphere and ocean." *Id.* at 14. *See also* William J. Broad, *Another Possible Climate Culprit: the Sun*, N.Y. TIMES, Sept. 23, 1997, at F1.

increase in the heat retained by the Earth. The most important of the greenhouse gases is CO_2, which is responsible for over half of the human influence on the global climate.[13] But other gases, such as methane (CH_4) and nitrous oxide (N_2O), also contribute to climate change.[14] Carbon dioxide concentrations in the atmosphere have increased from approximately 280 parts per million by volume (ppmv) before the industrial revolution to 358 ppmv by 1994.[15] This increase is undoubtedly due to human activity.[16] Over 80 percent of the increase in CO_2 results from the burning of fossil fuels, with the remaining increase coming largely from changes in land use.[17] This article will focus almost exclusively on fossil fuel burning as the cause of climate change.[18]

B. The Effects of Climate Change: Global, but Local

Climate change is the most global of environmental problems. It is global both in its causes and in the distribution of its effects. The behavior responsible for global climate change (for example, fossil fuel burning in automobiles and power plants) takes place on every continent. Similarly, its effects (for example, rising oceans) will occur around the planet.[19]

Nevertheless, many of the results of climate change will be intensely local. Although climate change will occur on a global level, its effects will likely vary greatly on the local level.[20] Part of this local variation results from the distinction between climate and weather.[21] A small change in global climate may reflect enormous and varied changes in local weather patterns.[22] For example, global climate change may lead to an increase in

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13. *See* CLIMATE CHANGE 1995, *supra* note 6, at 117. The importance of CO_2 to climate change is not a function of its effectiveness as a greenhouse gas as much as a reflection of the volume by which it has increased (and continues to increase). *See id.* at 22, 92. Methane, for example, is (in the short term) 56 times more powerful as a greenhouse gas than CO_2, but it is present in far smaller amounts in the atmosphere, and is not increasing in concentration as rapidly as CO_2. *See id.*

14. *See id.* at 117.

15. *See id.* at 14.

16. *See id.* at 14, 78.

17. For example, deforestation. *See id.* at 79.

18. The same analysis, however, could be applied to other causes of climate change as well.

19. *Cf.* William K. Stevens, *Experts on Climate Change Ponder: How Urgent Is It?*, N.Y. TIMES, Sept. 9, 1997, at C1 (discussing the likely global effects of climate change).

20. *See* CLIMATE CHANGE 1995, *supra* note 6, at 6 ("Regional temperature changes could differ substantially from the global mean value.").

21. *See, e.g.*, Andrew C. Revkin, *Who Cares About a Few Degrees?*, N.Y. TIMES, Dec. 1, 1997, at GW1 (discussing the difference between climate [large scale patterns in weather] and day to day weather [the particular manifestations of those patterns]).

22. *See id.*

the frequency of extreme weather.[23] The damage from increased rainstorms and snowstorms, and thus from global climate change, will be borne disproportionately by those communities with the misfortune to find themselves in the path of individual storms.

The manner in which people experience climate change will also vary locally because of the particular nature of some of the predicted effects. The IPCC, for example, predicts that global climate change will lead to a rise in sea levels of up to one meter by the end of the next century.[24] Such a rise would disproportionately damage communities living on or near coastal areas. Likewise, warmer temperatures could increase the geographic range of tropical diseases (for example, malaria).[25] People living in certain regions previously unaffected by such diseases would endure a particularly acute local manifestation of climate change.

C. Uncertainty

A final feature of climate change of particular importance to this article is the high level of uncertainty associated with predictions of specific consequences of changes in global climate. The substantial uncertainties surrounding various facets of the climate change problem can be divided into two general categories.

First, there are broad uncertainties regarding the functioning of the climate system on a global level.[26] These uncertainties hinder precise prediction of the aggregate and regional effects of global climate change.[27] Lack of scientific knowledge as to the likely effects of countless feedback mechanisms engenders uncertainty within the models used to predict the future path of the global climate. The uncertainty is particularly strong with regard to predictions of effects at the regional level.[28] Uncertainty about the global course of climate change is also associated with uncertainty regarding its likely overall economic costs.[29] By economic costs, I mean

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23. *See* Stevens, *supra* note 19.

24. *See* CLIMATE CHANGE 1995, *supra* note 6, at 39-41.

25. *See GLOBAL WARMING at NRDC: The Consequences of Global Warming* (visited Oct. 9, 1997) <http://www.nrdc.org/bkgrd/gwcons.html>.

26. For example, the IPCC report predicts that the global mean temperature will increase anywhere from one degree Celsius to three degrees Celsius by 2100. *See* CLIMATE CHANGE 1995, *supra* note 6, at 6. This type of uncertainty could be called "general uncertainty."

27. *See id.*

28. *See* William K. Stevens, *Computers Model World's Climate, but How Well?* N.Y. TIMES, Nov. 4, 1997, at F1.

29. *See, e.g.*, Stevens, *supra* note 3 (quoting Harvard economist Dale Jorgenson as saying that "[t]here's a lot more uncertainty about the economics [of climate change] than about the climate."). This uncertainty relates both to the costs produced by climate change itself (and hence the benefits of avoiding climate change) as well as the economic costs of the measures

both the direct damage produced by climatic change (for example, storm damage) and the costs of adapting to changes in global climate (for example, the costs of moving people away from coastal areas, shifting locations of food production, etc.). Uncertainty about these economic effects of climate change has played a large role in the failure to develop a coherent policy response to the problem.[30] Uncertainties falling within this first category will probably be gradually reduced over time as human understanding and technology improve.[31]

A second type of uncertainty, however, is unlikely to disappear any time in the near future. This more persistent uncertainty surrounds the specific effects of global climate change. If the first type of uncertainty is exemplified by questions such as how much the overall frequency of severe weather will increase because of climate change, the second type of uncertainty can be exemplified in the related, but fundamentally different, question of *precisely* when and where the additional severe weather will occur.[32] I call this second type of uncertainty "specific uncertainty."

Specific uncertainty can in turn be divided into two subcategories: first, ex ante questions of prediction; and, second, ex post questions of assigning responsibility. Ex ante questions of prediction involve attempts to determine before the fact when, where, and to whom specific effects will occur. Ex post questions involve attempts to determine which particular harms were caused by climate change, as against background causes.[33] Even if, for example, scientists were able to predict with a high degree of certainty that global climate change would create a 20 percent increase in the frequency of winter cyclones in the North Pacific over the next 30 years, there is currently no way to know with complete certainty (1) before the

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proposed for reducing the threat of climate change. For a more detailed discussion of the economic costs of carbon taxes, one of the most frequently proposed means of reducing carbon emissions, see Dale W. Jorgenson & Peter J. Wilcoxen, *Global Change, Energy Prices, & U.S. Economic Growth*, 3 STRUCTURAL CHANGE AND ECON. DYNAMICS 135 (1991) and Andrew Dean & Peter Hoeller, *The Costs of Reducing Carbon Dioxide Emissions*, OECD ECON. STUD., Winter 1992, at 16.

30. *See* Stevens, *supra* note 27.

31. *See, e.g., id.* (discussing how climate models have steadily improved over the past few decades).

32. This uncertainty therefore translates into a pervasive uncertainty about who precisely will bear the brunt of damage caused by climate change.

33. Weather events caused by El Niño provide a useful example of such a distinction. One can easily distinguish between the different types of uncertainty in discussions of the El Niño phenomenon. First, uncertainty over estimates of the aggregate climatic effects and economic costs attributable to El Niño would fall into the category of general uncertainty. Second, uncertainty over when and where a particular "El Niño storm" will occur would fall under the ex ante half of specific uncertainty. Finally, uncertainty over post hoc descriptions of a storm as an "El Niño storm" would fall under the ex post half of specific uncertainty.

fact, where and when the additional cyclones would occur or (2) after the fact, which particular cyclones were "in fact" due to climate change and which were due to "background" climatic processes. This specific uncertainty results from the deep complexity and sensitivity of the processes that produce weather, features that underlie the common characterization of weather as a chaotic system.[34] Such a characterization calls into question the likelihood that it is even possible to eliminate specific uncertainty.[35]

III. A TORT ANALYSIS OF GLOBAL CLIMATE CHANGE

A. The Appropriateness of a Tort Analysis

The nature of anthropogenic climate change suggests the appropriateness of applying tort principles to the problem. First, many of the costs of global climate change will take the form of damage to persons and property produced as a result of human activity, a concern that lies at the heart of tort law. The uneven nature of the effects of climate change reinforces the attractiveness of tort law as a potentially useful analytic tool. Because some extremely localized groups will likely bear a grossly disproportionate share of the costs produced by climate change (for example, people living in coastal areas or people suffering from malaria in previously temperate regions or people struck by a tornado that might not otherwise have occurred), the question of whether to leave these costs on the victims or somehow to transfer them to others comes into play. This distributional question is of central concern to the tort system.[36] Tort analysis provides the potential for a policy response to anthropogenic climate change that is sensitive to the diversity of *individual* losses likely to result

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34. *See, e.g.*, JOHN DUPRE, THE DISORDER OF THINGS: METAPHYSICAL FOUNDATIONS OF THE DISUNITY OF SCIENCE 175 (1993) (describing meteorological systems as paradigms of chaotic systems, i.e., systems in which prediction is impossible due to their enormous complexity and sensitivity).

35. I do not want to overplay the distinction between general and specific uncertainty. Reducing general uncertainty can, for example, also reduce specific uncertainty to a degree. If for example, scientists knew (with a high degree of certainty) that hurricanes in Florida would increase 800% by the year 2008 due to climate change, it would be possible to characterize a particular hurricane in Florida as a "climate change storm" with a higher degree of certainty than if scientists could only predict the effect of climate change on hurricane frequency (in general) to a very low degree of certainty. Nevertheless, the distinction between general and specific uncertainty is a useful one, especially when considering issues surrounding causation. *See infra* Part IV.A.

36. *See, e.g.*, GUIDO CALABRESI, THE COSTS OF ACCIDENTS: A LEGAL AND ECONOMIC ANALYSIS 26 (1970) (describing "fairness" in the distribution of accident costs as one of the fundamental goals of tort law).

from the human emission of greenhouse gases. It also provides a useful framework for analyzing the best ways to allocate costs associated with similar-looking harms that, in fact, result from a series of different sources.[37]

Furthermore, from a pragmatic viewpoint, a tort analysis may provide a workable framework for proposing policy initiatives. That is to say, tort law's language of forcing injurers to compensate victims of harm may provide a more palatable language for selling action on climate change to the American public than, for example, the language of taxation or regulation. Carbon taxes, one of the most common proposals for dealing with climate change,[38] would by themselves likely prove very difficult to sell, given the present anti-tax sentiment within the United States.[39] A tort-based policy, framed in terms of environmental restitution, on the other hand, might more successfully garner support.[40] Thus, Strauss and Urquhardt argue that public antipathy for gasoline taxes results from their perception as primarily fiscal measures, designed simply to raise money for the government at large.[41] A tort-based climate change policy, however, could unequivocally be portrayed as an environmental measure. Phrased in terms of protecting the environment and compensating the victims of human activity, it would likely not arouse the same passions as a simple rise in gasoline taxes.[42]

B. The Costs of Climate Change and the Goals of Tort Law

In considering who should bear the costs of damage to persons and property produced by climate change, it is helpful to focus on the two commonly identified goals of tort law: reducing the costs of accidents, that is

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37. See *infra* Part IV.B.1 for a discussion of the various splitting rules that have evolved within tort law to resolve problems associated with categories of effects that are associated with more than one type of cause.

38. *See, e.g.*, Dean & Hoeller, *supra* note 29 (discussing the carbon tax).

39. In the United States over the past few years, the tendency has been towards *lower* taxes on fossil fuels. During the last presidential election, for example, candidates from both parties sought to *lower* the tax on gasoline in order to curry favor with an electorate that is increasingly hostile to taxation. *See, e.g.*, Adam Clymer, *Democrats Reject a Dole Plan to Cut Gas Tax*, N.Y. TIMES, May 10, 1996, at A28 (describing political sparring over the proposed cut in the gas tax).

40. *See* Todd Strauss & John A. Urquhart, *Energy Prices and Environmental Costs*, in THINKING ECOLOGICALLY 217, 221 (Daniel C. Esty & Marian R. Chertow eds., 1997).

41. *See id.*

42. *See id.* at 222 ("The only way to overcome the political hurdles associated with energy taxes is to make the case on environmental grounds.").

the sum of accident and accident-avoidance costs; and corrective justice.[43] The application of either of these two goals to the problem of climate change justifies a policy that places the costs upon those parties that extract fossil fuels from the earth and convert them into usable form. As the following analysis shows, such an approach would lead to a more efficient level of fossil fuel consumption and would satisfy principles of corrective justice.

1. Reducing the Costs of Accidents

Reduction of total accident costs is commonly seen as one of the main goals of tort law.[44] This goal is most logically served by an economic approach and is often associated with the strict liability model of tort compensation.[45] Under an economic approach to the problem of accident cost reduction, the preferred assignment of liability would be the one that minimizes the sum of misallocation costs and transaction costs.[46] Misallocation costs result when, because of positive transaction costs, more, or fewer, accidents occur than would in the optimal state of affairs.

In the Coasian world of zero transaction costs (which includes perfect consumer knowledge), and disregarding wealth effects, the decision of who should bear the costs of harm caused by climate change would have no impact on the level of activities that result in climate change (for example, the burning of fossil fuels).[47] Parties would simply bargain around legal entitlements with the end result being the same level of activities. If the costs were left on the victims of harms caused by climate change, that is, if producers of fossil fuels were given the right to extract and sell fossil fuels, potential victims—in this case, all consumers—would band together to pay for reductions in the use of fossil fuels until the marginal cost of reducing fossil fuel consumption exceeded the savings due to the reduction in expected accident costs produced by the marginal reduction in the use of fossil fuels. This equilibrium point is represented by point C on Figure 1.

If, on the other hand, costs were put on the producers of fossil fuels (that is, if victims were granted the right to be free from the effects of anthropogenic climate change), then the producers would pay consumers to reduce their fossil fuel use until the marginal cost of a decrease in

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43. *See* CALABRESI, *supra* note 36, at 24-31 (discussing justice and reduction of accident costs as the two main goals of tort law).

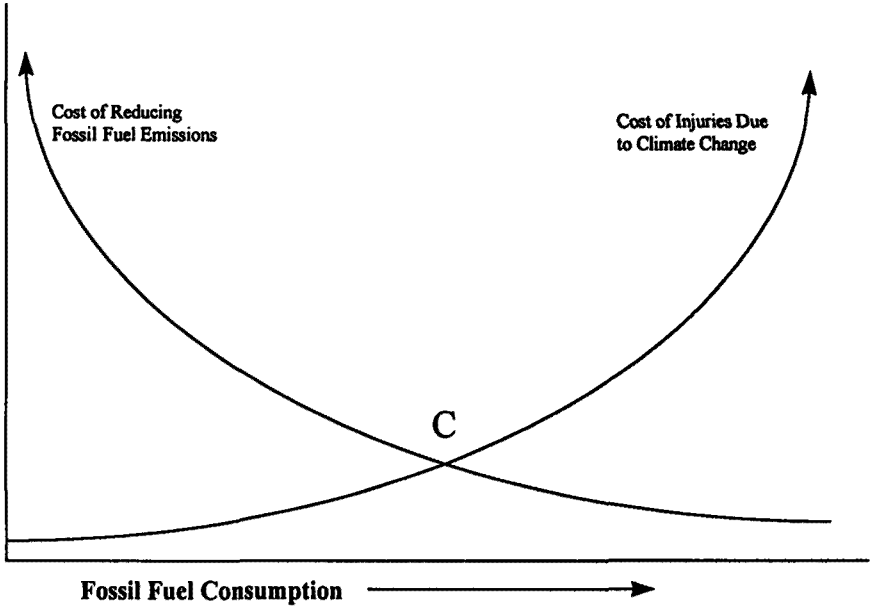
44. *See, e.g.*, Guido Calabresi & Jon T. Hirschoff, *Toward a Test for Strict Liability in Torts*, 81 YALE L.J. 1053, 1075 (1972) (arguing that strict liability better accomplishes the goal of accident cost reduction).

45. *See id.*

46. *See* A. MITCHELL POLINSKY, AN INTRODUCTION TO LAW AND ECONOMICS 13 (1983).

47. *See id.* at 17.

Figure 1



consumption was greater than the savings in costs due to the harm avoided by that reduction in fossil fuel consumption. Again, this equilibrium point would be represented by point C on Figure 1. Thus, in a world of perfect knowledge and no other transaction costs, the two alternative assignments of liability would result in the same level of fossil fuel consumption and expected costs of harms due to climate change.

In the real world of high transaction costs and less than perfect consumer knowledge, however, placing the costs of harms caused by anthropogenic climate change on those who suffer losses as a result of those harms insures that the activities causing climate change occur at a higher than optimal level. This result comes about because groups of victims and potential victims of accidents will not be able to organize, due to both their numbers and the specific uncertainty as to the accidents that will be caused by climate change. Further, the fossil fuel companies have engaged in activities aimed at *preventing* collective public action to combat the threat of climate change.[48] Thus, if costs are placed on victims, the price

48. *See infra* notes 60-61 and accompanying text.

of fossil fuels will not include the costs of harms caused by anthropogenic climate change, because of the legal assignment of the entitlement in favor of the producer; nor will victims be able to band together to pay for reduction in fossil fuel consumption, because of their lack of knowledge and poor organization. Instead, the costs of the harms produced by climate change will stand as an externality, borne by the victims and their insurers.[49] The result will be higher than optimal consumption of fossil fuels and hence higher than optimal "accident" costs.

As Calabresi argues, this externality is avoided by allocating the costs of accidents to the party with the lowest transaction costs. According to his theory of strict liability, accident costs should be allocated to the party in the best position to make the required cost-benefit analysis between increased consumption of the product and the increased costs of accidents caused by that consumption, and then to act on that analysis.[50] In so doing, misallocation costs and transaction costs are minimized.

In the case of climate change, the party with the lowest transaction costs, that is, the party in the best position to carry out the required cost benefit analysis and then act on it, is the fossil fuel industry.[51] First, and perhaps most important, the fossil fuel companies have an enormous amount of resources with which they can purchase the expertise needed to assess the often conflicting information about climate change and its expected costs. Second, once they have carried out the cost-benefit analysis, fossil fuel companies are better positioned to internalize the accident costs produced as a result of fossil fuel use, by incorporating the costs of expected accidents into the price of fossil fuels.[52]

Forcing producers of fossil fuels to internalize the costs of accidents caused by climate change will lead them to raise their prices to maintain profits.[53] Such a move might initially appear only to harm consumers, but

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49. *See* Darwin C. Hall, *Preliminary Estimates of Cumulative Private and External Costs of Energy*, CONTEMP. POLICY ISSUES, July 1990, at 283, 285; Jorgenson & Wilcoxen, *supra* note 29, at 135, 140.

50. *See* Calabresi & Hirschoff, *supra* note 44, at 1060.

51. The results of this cost-benefit analysis are indicated by the position on climate change adopted by the insurance industry, an industry that presently stands to bear the brunt of the costs of global climate change. *See infra* note 166 and accompanying text.

52. *Cf.* Cottle v. Superior Ct., 3 Cal. App. 4th 1367, 1402 (1992) (Lillie, J., dissenting) (arguing that failure to place the costs of injuries produced by chemicals on chemical manufacturers will lead to higher than optimal consumption of suspect chemicals due to artificially low prices).

53. Several authors have called for such an internalization of the environmental costs of energy use. *See, e.g.*, Hall, *supra* note 49, at 283 (calling for "social pricing" of energy); Strauss & Urquhart, *supra* note 40, at 218 (arguing that the price of energy should include the cost of environmental harms associated with energy use); Thomas C. Schelling, *Prices as Regulatory Instruments*, *in* INCENTIVES FOR ENVIRONMENTAL PROTECTION 1 (Thomas C. Schelling ed., 1983)

raising the prices of fossil fuels would also have the effect of making alternative, safer energy sources competitive.[54] If the price of fossil fuels were to reach high enough levels, the cost of further fossil fuel use would eventually exceed the cost to consumers of switching to alternative energies that do not release greenhouse gases or the costs of investing in alternative technologies that would increase the consumer's efficiency in the use of fossil fuels.[55] The result would be lower consumption of fossil fuels and a reduction in greenhouse gas emissions toward their optimal level.[56]

2. Compensating Victims and Punishing Wrongdoers

The injuries produced by global climate change could be potentially devastating. In some cases, such as harms caused by rising seas and the spread of tropical diseases, the particular injuries resulting from the build-up of greenhouse gases will be relatively easy to pick out.[57] In others, such as increased damage due to a higher frequency of lightening strikes[58] or more frequent and more severe hurricanes,[59] the harms caused by climate change will be difficult to distinguish from background processes. But in either case, actual people will be seriously harmed who, but for global climate change, might not have been.

(arguing for the internalization of costs associated with environmental harm caused by energy production and use). Often referred to as "social pricing," the practice of internalizing the costs of environmental harms produced by energy policy has not been analyzed from the perspective of tort law. Schelling's analysis comes closest to a tort approach in that he calls for the revenue raised from environmental taxes to be paid out to parties who have been damaged by environmental degradation. As I discuss below, moreover, the failure to conceive of the internalization process in expressly tort-based language removes the important moral feature of tort analysis.

54. *See* Thomas Sterner et al., *Gasoline Tax Policy, Carbon Emissions & the Global Environment*, 26 J. TRANSP. ECON. & POL. 109, 112 (1992). A significant issue of distributive justice, however, is raised by the problem of the higher energy prices that would ensue from the implementation of the policies recommended in this paper. The negative effects of higher energy prices on poor consumers (i.e., the costs of programs to ameliorate these effects) should be factored in to any cost-benefit analysis of energy prices.

55. *See id.*

56. *See id.* at 116-18.

57. *See Watery Disaster Looms Without Emissions Curbs, Leaders Warn* (visited July 14, 1997) <http://www.cnn.com/EARTH/9706/24/earth.summit.wrap/index.html>.

58. *See, e.g.*, C.G. Price, Global Lightning Activity and Climate Change (1993) (unpublished Ph.D. dissertation, Columbia University) (on file with author)(arguing that under a scenario where global CO_2 concentrations doubled, the mean annual frequency of lightening fires in the United States could increase by 40%).

59. *See, e.g., How Will the Frequency of Hurricanes be Affected by Climate Change?* (visited June 12, 1997) <http://www.giss.nasa.gov/Research/Intro/druyan.02> (suggesting that with a doubling of CO_2 concentrations in the atmosphere, the frequency of hurricanes forming over the North Pacific Ocean could double).

Tort law is often discussed in primarily economic terms.[60] Even those who engage in such economic analysis, however, are often willing to admit that there is an irreducibly ethical component to tort liability.[61] This ethical goal of the tort system is normally satisfied by compensating the victims of accidents caused by the negligent, and sometimes morally dubious, behavior of others.[62] If the sole goal of tort law were the efficient pricing or consumption of products that cause injuries, then compensation of victims of accidents caused by those products would not necessarily be required. But our notions of justice and fairness require the compensation of those whose lives have been harmed by others' negligence.[63]

Sometimes, however, in addition to compensating victims, the goal of justice in tort law demands that a stigma be placed on injurers.[64] The tort

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60. *See, e.g.*, RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW § 6.1-17 (4th ed. 1992) (analyzing tort law in terms of economic efficiency); CALABRESI, *supra* note 36 (providing a fundamentally economic analysis of tort theory).

61. *See, e.g.*, CALABRESI, *supra* note 36, at 24-26 (naming "justice" as one of the two main goals of tort law). *See also, e.g.*, David Fischer, *Proportional Liability*, 46 VAND. L. REV. 1201, 1203 (1992) (describing corrective justice as one of the main policies underlying tort liability); Glen O. Robinson, *Probabilistic Causation and Compensation for Tortious Risk*, 14 J. LEGAL STUD. 779, 789 (1985) (discussing corrective justice as an objective of tort law). For an analysis more focused on the moral aspects of tort law, see Stephen R. Perry, *Moral Foundations of Tort Law*, 77 IOWA L. REV. 449 (1992).

62. *See* Jules L. Coleman, *Tort Law and the Demands of Corrective Justice*, 67 IND. L.J. 349, 357 (1992). But, it is important to remember, as Professor Coleman does, that the *immorality* of the injurer is not required in order for corrective justice to demand compensation of the victim. *See id.* at 370. "Lack of capacity to comply with the standard of due care may free an individual from moral sanction; normally it will not suffice, however, to free him from tort liability." Jules L. Coleman, *Moral Theories of Torts* (pt. 1), 1 LAW & PHIL. 371, 375 (1982) [hereinafter Coleman, *Moral Theories I*].

63. *See, e.g., id.* (describing the "annulment" of wrongful losses as one of the demands of corrective justice); Schelling, *supra* note 53, at 29 (discussing the need to compensate the victims of environmental harms). Professor Coleman attempts to place a conceptual divide between grounds for awarding damages to a victim and grounds for imposing costs on an injurer. *See* Jules L. Coleman, *Moral Theories of Tort* (pt. 2), 2 LAW & PHIL. 5, 8 (1982). According to Professor Coleman's theory, there are some circumstances in which corrective justice may require compensation of a victim, but not the liability of the injurer (i.e., when the injurer does not gain from the victim's loss). On the other hand, he argues, there may be some cases in which corrective justice requires the annulment of a party's gain (i.e., when it is wrongful), even if that party's actions do not injure anyone. Professor Weinrib has disputed the ability of Professor Coleman's theory to serve as the basis for tort law. *See* Ernst J. Weinrib, *Toward a Moral Theory of Negligence Law*, 2 LAW & PHIL. 37, 39 (1982). The situation of concern in this article does not require one to take sides in the debate between Professors Coleman and Weinrib. Under Professor Coleman's theory, the current situation would be characterized as one in which the losses being annulled (i.e., the damage done to people harmed by climate change) are related to the wrongful gains of the injuring party.

64. I am not proposing a wholly moral theory of fault-based tort liability. As Professor Coleman has rightly pointed out, moral responsibility and tort liability are not coterminous

notion of negligence often contains within it a feature of moral stigma.[65] Attempts to impose liability on a party are often imbued with a moral content, a desire to label the defendant as a wrongdoer. No one *wants* to be called a tortfeasor, after all. Thus, even victims who fail to win monetary damages for themselves may feel at least partially vindicated by exposing the fault of the party they consider to be in some way morally responsible for their injury.[66] This moral, symbolic element of the tort system, usually associated with defense of the fault-based theories of tort compensation,[67] is not reducible to economic arguments. Rather, moral judgment stands by itself as an independent, though often related, goal of tort liability.[68]

As with the goal of efficiency, the requirements of corrective justice in tort law are consistent with a decision to place the costs of accidents caused by global climate change on fossil fuel companies. Depending upon one's views of the facts of climate change, the behavior of these parties appears to meet Learned Hand's definition of negligence.[69] According to this definition, a party is negligent if the expected costs of accidents, discounted by the likelihood that the accident will occur, are greater than the costs of avoiding those accidents.[70]

Evidence of the negligence on the part of fossil fuel companies can be found by an analysis of the historical role that they have played in thwarting efforts to increase the use of alternative energy sources and in

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categories. *See* Coleman, *Moral Theories I*, *supra* note 62, at 378. Nevertheless, it would be wrong to conclude from this that moral considerations are completely absent from all determinations of tort liability under the fault system.

65. *See, e.g.*, Weinrib, *supra* note 63, at 54 (characterizing the failure to live up to the objective standard of due care as "a [moral] failure to give equal consideration to the plaintiff and . . . thus [as] a wrong directed against him.").

66. This punitive, stigmatizing aspect of tort law is exemplified most clearly in tobacco litigation, where victims against a morally bankrupt injurer view tort law almost with the fervor of a moral crusade. *Cf.* Mireya Navarro, *Cigarette Makers Reach Settlement in Nonsmoker Suit*, N.Y. TIMES, Oct. 10, 1997, at A1 (describing plaintiffs' satisfaction with a suit in which they received no money, because the tobacco industry had effectively conceded that, despite its frequent statements to the contrary, second-hand smoke causes lung cancer).

67. *See, e.g.*, CALABRESI, *supra* note 36, at 301 ("It strikes critic and community as unfair if a person injured by someone who has violated a moral code is not compensated, or if someone who violates a moral code and is hurt is compensated at the expense of an innocent party."). *See also* Weinrib, *supra* note 63, at 52 (interpreting the Learned Hand test for negligence as an example of Kantian moral reasoning).

68. *See* Weinrib, *supra* note 63, at 53 ("The balancing of risk against the measures needed to eliminate or avoid the risk stands at the junction of the paradigmatically deontological elements of rationality in a hypothetical situation.").

69. The Hand Test is the standard test for fault-based liability in tort law. *See* RICHARD A POSNER, TORT LAW 1-2 (1982).

70. *See id.*

impeding efforts to improve efficiency in energy use.[71] Assuming that global climate change is a real threat, these companies have placed the balance of the planet into jeopardy. Despite a growing scientific consensus that the continued reliance on fossil fuels is putting the stability of the environment at serious risk, they have attempted to block efforts at reducing the growth of CO_2 emissions in order to protect their profits.[72] The more certain scientists become that global climate change is occurring, and the more potentially catastrophic the consequences of climate change appear to be, the more negligent and, as a result of the enormous potential costs of that negligence, morally irresponsible the behavior of these parties appears.

By taking some action to reduce fossil fuel consumption, the fossil fuel companies could reduce the actual costs associated with harms caused by climate change.[73] The failure of the fossil fuel companies to take any action to reduce the risk of global climate change amounts to an assertion that the appropriate level of expenditure to avoid climate change is zero. Thus, if it can be shown that there is any risk that costs will result from climate change, the behavior of the fossil fuel companies would appear to meet the Learned Hand definition of negligence. That is, assuming that there will be some costs of climate change,[74] the refusal of fossil fuel

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71. *See* Ross Gelbspan, *Beyond Kyoto*, AMICUS J., Winter 1998, at 22, 24 ("To date, fossil fuel interests have been devoting enormous resources to confounding the public with an appalling public relations campaign of deception and misinformation."). Of course, an argument could be made that victims of accidents caused by climate change, have (by using fossil fuels) engaged in contributory negligence. Such an argument is only superficially appealing, however. The public campaigns carried out by fossil fuel companies have made it very difficult for the average consumer to accurately weigh the risks involved in continued use of fossil fuels.

72. Fossil fuel companies have employed public opinion campaigns using dubious scientific research in an effort to prevent a consensus from forming around the need to reduce fossil fuel consumption. *See id. See also* Cushman, *supra* note 1; Industry Battles Clinton on Climate, UPI, Sept. 10, 1997 (describing a $13 million industry public relations campaign to try to prevent the United States from signing on to a commitment to significantly reduce CO_2 emissions); *Who's Warming the Globe?*, BUFFALO NEWS, Dec. 17, 1995, at 8F (describing the oil industry's attempt to create uncertainty over global warming by funding "hired guns" to perform research). Speaking to a Chinese audience at the 1997 World Petroleum Conference in Beijing, for example, Exxon chairman Lee Raymond urged developing Asian nations to *increase* their fossil fuel use and to work with Exxon to oppose greenhouse gas reductions. *See* Colum Lynch, *Stormy Weather*, AMICUS J., Winter 1998, at 15, 17. For a thorough discussion of the fossil fuel companies' attempt to skew public debate in their favor through the use of questionable science, see generally ROSS GELBSPAN, THE HEAT IS ON: THE HIGH STAKES BATTLE OVER EARTH'S THREATENED CLIMATE (1997).

73. *See supra* Figure 1.

74. That is, I assume that the costs of climate change are greater than 0.

companies to spend any money to reduce the risk of such harm amounts to a failure to show due care.

The negligence of fossil fuel producers may amount to a twist on the claim of "negligent marketing."[75] That is, the negligence of fossil fuel companies does not result from their decision to market fossil fuels at all, but rather from their decisions to refuse to market them in a responsible way. In a dissenting opinion, Judge Calabresi of the Second Circuit applied a form of the negligent marketing theory to the manufacturer of Black Talon bullets.[76] In considering the application of the Learned Hand test to the way in which Olin Corporation marketed the Black Talon bullet, Judge Calabresi argued that if "the social utility of marketing the product to the public is outweighed by its risk of harm," then the manufacturer can be found liable under a negligent marketing theory.[77] In other words, if the costs of marketing the bullets in a less dangerous way are outweighed by the costs of accidents avoided by the less dangerous marketing technique, the failure of the manufacturer to adopt the less dangerous marketing technique amounts to a negligent act for which the manufacturer can be held liable.[78]

Applied to the case of fossil fuels, the negligent marketing theory, as described by Judge Calabresi, would result in a finding of negligence by fossil fuel producers as long as it could be shown that costs would indeed result from the harms associated with climate change. The negligent marketing claim would amount to an argument that the cost for fossil fuel producers of helping to reduce the consumption of fossil fuels is outweighed by the social costs associated with fossil fuel consumption in excess of point C on Figure 1 above. The failure of fossil fuel companies to market their product consistently with the cost-benefit analysis described in Part III.B.1 amounts to the negligent marketing of fossil fuels.

IV. PROBLEMS WITH A TORT ANALYSIS OF GLOBAL CLIMATE CHANGE

Although the two major goals of tort law point in the direction of placing the costs of the accidents produced by climate change on the enterprises responsible for the production of fossil fuels, several problems

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75. For one discussion of the theory of negligent marketing, see Andrew J. McClurg, *The Tortious Marketing of Handguns*, 19 SETON HALL LEGIS. J. 777, 799, 806-08 (1995) (explaining the theory of negligent marketing—marketing an otherwise non-negligent product in a negligent manner—as a basis for liability for handgun manufacturers) (*cited in* McCarthy v. Olin Corp., 119 F.3d 148, 161 [2d Cir. 1997] [Calabresi, J., dissenting]).

76. *See McCarthy*, 119 F.3d at 161-70 (Calabresi, J., dissenting on other grounds).

77. *Id.* at 162.

78. *See id.*

are likely to arise in any implementation of a tort-based approach to the costs of climate change. The most serious of these problems have to do with issues surrounding causation, determination of how much each responsible party should pay, and the most appropriate mechanisms for administering such a tort-based approach.

A. Causation

Perhaps the single greatest problem with using a tort-based approach to climate change would be proving that any individual injury was caused by human activity. In this regard, climate change suffers from the same causation problems that plague toxic torts in general.[79] To the traditional problems of causation inherent in any toxic tort, however, climate change adds its own.

Before discussing how climate change differs from traditional toxic torts, it is important first to outline the ways in which toxic torts in general present serious problems of causation. Susan Poulter divides the causation problem into two categories: (1) general causation and (2) individual causation.[80] General causation involves the question of whether the alleged causal factor can cause the type of effect from which the victim suffers (for example, can asbestos in general cause lung cancer?). The issue of individual causation, however, involves the question of whether the alleged causal factor did indeed cause a particular victim's injury (for example, did asbestos exposure cause *this case* of lung cancer?). It is this latter notion of individual causation, normally conceived of in terms of *but for* causation, that is thought to be the concern of the tort process,[81] and it is this latter causal notion that presents the greatest problem for toxic torts.[82]

The problem for toxic torts stems from the tendency of tort law, and tort scholars, to conceive of individual causation in the mechanistic

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79. *See* Cottle v. Superior Ct., 3 Cal. App. 4th 1367, 1399-1401 (1992) (Lillie, J., dissenting) (discussing the difficulties of proving causation "in fact" in toxic tort cases). *See also, e.g.*, Susan R. Poulter, *Science and Toxic Torts*, 7 HIGH TECH L.J. 189, 198 (1992) (describing the proof of causation as the biggest stumbling block to recovery in toxic tort cases).

80. *See id.* at 216.

81. *See* Troyan A. Brennan, *Causal Chains & Statistical Links*, 73 CORNELL L. REV. 469, 490 (1988) (arguing that the *but for* causal inquiry tends to dominate tort proceedings). *See also* Richard W. Wright, *Causation, Responsibility, Risk, Probability, Naked Statistics, and Proof*, 73 IOWA L. REV. 1001, 1019 (1988) (arguing that the causal inquiry in torts is an individualized, *but for* causal inquiry).

82. *See, e.g.*, Cottle, 3 Cal. App. 4th at 1400 ("[W]hen a plaintiff is exposed to a toxic and subsequently suffers some disease or injury no expert honestly can testify that the toxic caused that particular individual to experience that particular disease or injury.").

(deterministic) sense of *but for* causation.[83] Richard Wright exemplifies this tendency, defining "actual" cause as a "necessary element in a set of antecedent actual conditions that were sufficient for the occurrence of the result."[84] As Wright points out, his definition is quite similar to the definition of causation in terms of counterfactual conditionals proposed by J.L. Mackie. Mackie defines a causal claim as roughly meaning that, given the circumstances, if the cause had not occurred, the effect would not have occurred. That is, given the circumstances, a cause is necessary for its effects.[85] Inherent in this mechanistic understanding of the world is the notion that all events proceed, by necessity, as a result of the conjunction of (1) a preceding state of affairs and (2) a set of universal, exceptionless, and, at least in principle, discoverable laws of nature.[86]

Poulter outlines several features of toxic torts that make this individualized, mechanistic, *but for* causal inquiry particularly problematic: (1) the long latency period between "exposure" to the suspect toxic substance and the victim's injury, diminishing the likelihood that the victim will suspect the toxic substance as the cause or be able to marshal the evidence necessary to prove it; (2) exposure at very high levels may not result in the disease in most persons; (3) background levels of the injuries exist; and (4) other risk factors may contribute to the victim's chances of developing a disease (for example, a person exposed to asbestos who has also smoked several packs of cigarettes a day for many years).[87]

Because of these features of toxic torts, often the best plaintiffs can do is to produce scientific evidence—usually in the form of statistical, epidemiological studies—pointing toward the suspected causal agent as a factor contributing to the victim's injuries.[88] Such epidemiological evidence takes the form of a probabilistic judgment as to relative risk (RR), that is, the difference in risk of acquiring a given condition between populations

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83. *See* Brennan, *supra* note 81, at 471.

84. Wright, *supra* note 81, at 1019.

85. *See* J.L. MACKIE, THE CEMENT OF THE UNIVERSE 39-43 (1974).

86. *See* DUPRE, *supra* note 34, at 178. *See also, e.g.*, Wright, *supra* note 81, at 1044 (defining a causal law as an invariable, nonprobabilistic causal connection between some fully specified set of conditions and some result). The deterministic model of causation proceeds along the lines of what Dupre calls "deductive-nomological" explanation. *Id.* To explain something under this mode of explanation is to say that E (the event being explained) results necessarily from C (its cause), where at least part of C is at least one law of nature. *See* DUPRE, *supra* note 34, at 178.

87. *See* Poulter, *supra* note 79, at 198-99. *See also, e.g.*, Dafler v. Raymark Indus., 611 A.2d 136 (N.J. Super. Ct. App. Div. 1992) (describing a plaintiff who smoked two packs of cigarettes a day for 30 years and was exposed to asbestos for 26 years before acquiring lung cancer).

88. *See* Fischer, *supra* note 61, at 1203 (noting that the problems of proof associated with modern toxic tort cases often require plaintiffs to rely on epidemiological evidence).

that have been exposed to the suspect factor and those that have not.[89] Given the preference of tort law for a deterministic conception of causation, it is not surprising that many courts and scholars have concluded that plaintiffs relying on such epidemiological evidence must show that, more probably than not, their individual injuries were caused by the particular risk factor in question, as opposed to any other cause.[90] In other words, plaintiffs would be required to prove that the RR of a given substance was greater than 2.0.[91] In the Ninth Circuit, an RR of greater than 2.0 is required for epidemiological evidence even to be admissible.[92]

All of the factors that hinder recovery in toxic torts are, to some extent, present in the case of global climate change. But in particular, the existence of background levels of the effect and the potential of interference from competing causes make the problem of proving causation in the case of a climate change injury particularly acute. First, the injuries caused by climate change involve shifts in climatic activity and not the creation of distinctive new types of phenomena. Second, making matters more difficult, these background levels are subject to their own natural fluctuations in frequency and severity.[93] This occurs because there are usually several factors that contribute to the frequency of the types of climatic

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89. RR is expressed as a ratio, with the risk in the exposed population in the numerator and the risk in the unexposed population in the denominator (e.g., if the risk in the exposed population is twice that of the unexposed population, the RR is 2.0). *See* Gerald W. Boston, *Toxic Apportionment: A Causation and Risk Contribution Model*, 25 ENVTL. L. 549, 613 (1995).

90. *See, e.g., In re* Agent Orange Product Liability Litigation, 611 F. Supp. 1223, 1253 (E.D.N.Y. 1985) (holding that plaintiffs must prove that Agent Orange was more likely than "anything else" to be the cause of their injuries); Bert Black & David E. Lilienfeld, *Epidemiological Proof in Toxic Tort Litigation*, 52 FORDHAM L. REV. 732, 767 (arguing that plaintiffs should be required to show that a particular suspect factor is responsible for over 50% of the injuries from which he suffers); Poulter, *supra* note 79, at 228 (arguing that plaintiff should have to prove that the factor to which he was exposed at least doubles the background rate of the injury from which he suffers).

91. *See, e.g.*, De Luca v. Merrell Dow Pharms., Inc., 911 F.2d 941, 958 (3d Cir. 1990) (requiring Bendectin plaintiffs to establish RR of greater than 2.0 in order to avoid summary judgment for the defendant); Hall v. Baxter Healthcare Corp., 947 F. Supp. 1387, 1403 (D. Or. 1996) (requiring breast implant plaintiffs to show an RR of at least 2.0 in order to prove causation); Manko v. United States, 636 F. Supp. 1419, 1434 (W.D. Mo. 1986) (equating RR of 2.0 with "more likely than not" proof of causation); Marder v. G.D. Searle & Co., 630 F. Supp. 1087, 1092 (D. Md. 1986) (stating that in IUD litigation, proof of causation by a preponderance of the evidence through epidemiological evidence required a showing of RR greater than 2.0); Landrigan v. Celotex Corp., 579 A.2d 1268, 1272 (N.J. Super. 1990) (holding that an RR of 2.0 or greater is required in order for epidemiological study to support causal claim). *Cf.* Merrell Dow Pharms., Inc. v. Havner, 953 S.W.2d 706, 717 (Tex. 1997) (noting that epidemiological evidence is only indirect evidence of a causal relation). *But see In re* Joint Eastern & Southern Dist. Asbestos Lit., 52 F.3d 1124, 1134 (2d. Cir. 1995) (rejecting the 2.0 RR requirement).

92. *See* Daubert v. Merrell Dow Pharms., Inc., 43 F. 3d 1311, 1321 (9th Cir. 1995).

93. *See* Broad, *supra* note 12.

activity that will likely result from climate change. Thus, it will be impossible to say with any certainty which particular lightning strikes were caused by global climate change and which ones would have occurred anyway.

Under the rule requiring proof that a given causal factor (in this case, climate change) more likely than not caused a particular injury, climate change victims would have to show that human activity has more than doubled the risk of their injury. If for example, a lightning strike or hurricane damaged the victim, she would have to show that as a result of climate change, the frequency of lightning strikes or hurricanes has more than doubled. There are, however, two reasons for rejecting such a mechanistic, individualized approach to causation. First, it is inconsistent with the current state of scientific knowledge[94] and, second, it is inconsistent with the two goals of tort law.

1. Epistemological Reasons for Rejecting the Deterministic Notions of Causation

The notion of a world governed by a web of *but for* causation, ordered in turn by discoverable, exceptionless laws of nature, is based upon a largely eighteenth century, corpuscularian metaphysics.[95] Such an understanding of the world was set forth in detail by Locke, in his *Essay Concerning Human Understanding*.[96] Although tort law has clung to this Laplacian notion of causation, science—and perhaps even more so the philosophy of science—has largely abandoned this understanding for an indeterminate, probabilistic notion of causation.[97] "The viewpoint is becoming more and more prevalent," says Herbert Simon, "that the appropriate scientific model of the world is not a deterministic model, but a probabilistic one."[98] This shift from deterministic theories of causation to probabilistic ones has been accelerated by science's embrace of quantum

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94. *See* Brennan, *supra* note 81, at 471 (arguing that scientific notions of mechanistic, *but for* causation are informed by a Newtonian scientific understanding that is no longer essential to science); Margaret G. Farrell, 15 CARDOZO L. REV. 2183, 2192 (1994) (arguing that common law concept of causation is grounded in Lockean empiricism and mechanistic models of causal chains which are inconsistent with contemporary scientific thought).

95. *See id.* at 471.

96. JOHN LOCKE, AN ESSAY CONCERNING HUMAN UNDERSTANDING (A.D. Woozley ed., 1964) (1689). For Locke, the world (as it is of itself) consists in microscopic, solid, extended bodies in motion. *See id.* at 112-19.

97. *See Brennan, supra* note 81, at 478; Farrell, *supra* note 94, at 2192; Daniel Lerner, *On Cause and Effect, in* CAUSE AND EFFECT 1, 6 (Daniel Lerner ed., 1965) (observing that science now operates in a probabilistic universe); Ernst Mayr, *Cause and Effect in Biology, in* CAUSE AND EFFECT, *supra*, at 33, 45 (claiming that nearly all biological predictions are statistical in nature).

98. Herbert A. Simon, *Causal Order and Identifiability, in* CAUSE AND EFFECT 157, 158 (Daniel Lerner ed., 1965).

mechanics.[99] James Fetzer has hailed the resultant shift in scientific thinking as "the most striking feature of the history of science since Newton."[100] The law's failure to embrace the new scientific understanding of causation leads it to view probabilistic, epidemiological evidence as second-best, *indirect* evidence of "real" (that is, *but for*) causation.[101]

Not only is this refusal of the law to modify its understanding of causation out of step with scientific understanding and rooted in an eighteenth century metaphysics, it is also epistemologically unsound. As Dupre argues, the deterministic metaphysic is largely the result of human prejudice derived from observations of the macro world.[102] But Dupre provides two convincing reasons for setting aside such prejudice. First, he argues, determinism is utterly lacking in empirical support.[103] A fortiori, its claim that exceptionless laws of nature govern the entire universe can never be proved.[104] But even if one ignores this logical point, Dupre rightly observes that, although it may display predictability, the world around us rarely displays deterministic behavior.[105]

Predictability does not entail determinism.[106] A series of highly probable correlations could just as easily lead to the regularity we observe in nature. Belief in determinism thus seems to be an expression of faith, more than a well-founded belief based on solid empirical evidence. Indeed, because of the empirical nature of the determinist's claim, it is quite significant that the most widely accepted scientific theories are more consistent with a probabilistic understanding of causation than a deterministic one.[107]

In the normal course of events, such an unjustified prejudice in favor of deterministic causation does not cause tort law many problems.

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99. *See* Brennan, *supra* note 81, at 481.

100. James H. Fetzer, *Probabilistic Metaphysics*, *in* PROBABILITY AND CAUSALITY 109 (James H. Fetzer ed., 1988).

101. *See* Brennan, *supra* note 81, at 490. *Cf.* Missouri v. Illinois, 200 U.S. 496, 526 (1906) (Holmes, J.) (rejecting a suit by the state of Missouri seeking to enjoin Illinois from dumping raw sewage from the city of Chicago into a tributary of the Mississippi River, because Missouri had failed to prove that the sewage was causing an increase in typhoid in St. Louis, even though Missouri had shown that the incidence of typhoid in St. Louis had increased over 75% since Chicago began dumping its sewage into the river).

102. *See* DUPRE, *supra* note 34, at 214.

103. *See id.*

104. *See id.* at 185.

105. *See id.* at 186.

106. Or vice versa, as chaos theory makes clear.

107. *See* DUPRE, *supra* note 34, at 189. *Cf.* Farrell, *supra* note 94, at 2194 (arguing that the uncertainty principle has radically undermined and replaced Newtonian, deterministic notions of causation).

Many torts involve events in the macro world.[108] The application of this prejudice to situations that involve events occurring primarily on the micro level, where determinism is far less intuitively appealing, is unjustified. Most toxic torts involve just such circumstances.

Jettisoning the notion of deterministic causation, Dupre proposes a probabilistic theory of causation that bears remarkable similarity to the causal reasoning involved in epidemiology. Dupre argues we should compare otherwise fair samples (that is, samples where background causes occur with the same frequency as they do in the general population), one of which contains the factor under examination and the other of which does not. If the effect occurs with greater frequency in the sample containing the factor with which we are concerned, then that factor should be considered a cause of the effect.[109] This is not to say that Dupre's analysis is perfect. Indeed, standing by itself, its failure to include a requirement of temporal priority makes it unappealing as a tool for distinguishing a cause from its effect.[110] But the changes needed to make Dupre's definition of causation more sound do not alter its fundamental feature: a probabilistic understanding of causation.

The analysis endorsed by Dupre is virtually identical to that used by epidemiologists in their efforts to determine the causal effectiveness of a particular factor. Epidemiologists conclude a factor is causal when it coincides, beyond what is likely to occur by chance, with the supposed effect within a given population.[111] Dupre's definition is also quite similar to other probabilistic definitions proposed by philosophers of science. Suppes, for example, argues that causes should be defined as those factors that raise the chances of their effects.[112]

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108. *See, e.g.*, Terranella v. Union Bldg. & Const. Co., 3 N.J. 443, 443 (1949) (describing a case in which a boy died due to injuries contracted while playing on large concrete pipes).

109. *See* DUPRE, *supra* note 34, at 203-04.

110. Under a definition whereby a cause is characterized by its tendency to raise the frequency of its effects, failure to include a requirement that the cause precede the effect leads to the paradoxical conclusion that an effect can also be considered as a cause of its own supposed cause (since the presence of the effect also raises the likelihood of the presence of its cause).

111. *See* Mervyn Susser, *Falsification, Verification, and Causal Inference in Epidemiology, in* CAUSAL INFERENCE 33, 37 (Kenneth J. Rothman ed., 1988). Epidemiologists generally require that a series of additional criteria (e.g., time order, specificity, consistency, predictive performance, and coherence) be satisfied before a relation can be considered causal. *See id.* at 39-50.

112. Suppe's actual analysis is far more complex. His theory ultimately amounts to a definition of cause as follows: C (cause) causes E (effect) if t' precedes t, and $p(Et'/Ct') > P(Et)$, and there is no such Ft'' such that t'' precedes t' and $p(Et/Ct'Ft'') = p(Et/Ft'')$. *See* Wayne A. Davis, *Probabilistic Theories of Causation, in* PROBABILITY AND CAUSALITY 133, 151 (James H. Fetzer ed., 1988). The idea that a cause is that which raises the chances of its effects is also strikingly similar to Calabresi's "causal link." Guido Calabresi, *Concerning Cause and the Law*

The adoption of a probabilistic notion of causation would go far towards solving many of the problems of proving causation in toxic tort cases. Probabilistic, epidemiological evidence would no longer be viewed as second-best, indirect proof of some underlying, invisible actual causation. Rather, such evidence would be direct proof of the probabilistic causal link itself.

At this point, it may be useful to distinguish between two concepts in epidemiology: strength of association and statistical significance.[113] As discussed above, some courts and tort scholars have argued that epidemiological evidence should be required to prove that a particular factor causes a doubling in the risk of being injured within the exposed population.[114] The reason for this is that, because these courts and scholars assume a mechanistic notion of causation, they have thought of epidemiological evidence as *indirect* proof of a causal link.[115] To prove, by a preponderance of evidence, that a given factor was the cause of the plaintiff's injuries, they would require that the plaintiff establish that the causal factor was more likely to be the "real" cause than any other factor, or combination of factors. The only way to accomplish this proof would be by showing that over half of the injuries of the type suffered by the plaintiff were caused by the alleged factor.

If one rejects the mechanistic notion of causation, however, and embraces a probabilistic one, then (for purposes of standards of proof) the statistical significance of an association becomes much more important than the degree to which the factor raises the incidence of the effect (that is, the strength of association). The two concepts, though easily confused, must not be.[116] It is quite common for a factor to be weakly associated with an effect, but for that weak association to have a strong degree of certainty. As epidemiologist Mervyn Susser points out, "an association may be weak and yet highly significant."[117]

For purposes of establishing a causal connection, courts should focus on the statistical significance of data rather than the strength of association. Epidemiologists, concerned much more about false positive correlations than false negatives, require 95 percent confidence in order for

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of Torts, 43 U. CHI. L. REV. 69, 71 (1975).

113. *See* Susser, *supra* note 111, at 42.

114. *See supra* note 90 and accompanying text.

115. *See, e.g.*, DeLuca v. Merrell Dow Pharms., Inc., 911 F.2d 941, 958 (3d Cir. 1990) ("epidemiological studies do not provide direct evidence that a particular plaintiff was injured by exposure to a particular substance . . . [but only provide] circumstantial evidence.").

116. *See* Susser, *supra* note 111, at 42.

117. *Id.*

data to be valid.[118] As Richard Lempert argues, however, "the values of social science are not the values of law."[119] Professor Lempert and others have observed that the use of the 95 percent confidence level within epidemiology is somewhat arbitrary and is based upon reasons that, although they may make sense within the realm of science, are not necessarily compelling within the courtroom.[120] Because the law is as concerned with the possibility of "false negatives" as it is with the possibility of "false positives,"[121] the statistical significance requirements for the courts should be neutral between the two dangers.[122] A confidence level of 50 percent would accomplish this task and would still be consistent with the requirement that admitted evidence make the "existence of any fact that is of consequence to the determination of the action more probable . . . than it would be without the evidence."[123]

Adoption of a probabilistic understanding of causation in tort law would open the way for claims based on accidents "caused" (in the probabilistic sense) by global climate change. Under the deterministic

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118. *See* Poulter, *supra* note 79, at 261. *See also* Susser, *supra* note 111, at 40 (noting that the weight attached to statistical significance in epidemiology contributes to a bias towards skepticism within the field).

119. Richard Lempert, *Statistics in the Courtroom*, 85 COLUM. L. REV. 1098, 1099 (1985).

120. *See id.*; Poulter, *supra* note 79, at 261; Daniel Rubenfeld, *Econometrics in the Courtroom*, 85 COLUM. L. REV. 1048 (1985). In particular, Lempert observes that scientists are under no pressure to pass judgment on a proposed causal relationship and are free to wait for more compelling evidence before reaching a conclusion. *See* Lempert, *supra* note 119, at 1100. Courts, on the other hand, have no such luxury. They must come to a conclusion one way or another, and so it makes little sense to withhold possibly useful evidence merely because it fails to meet the standards of a different discipline, standards which were adopted for completely different circumstances. *See id.*

121. *See* D.H. Kaye, *Apples and Oranges: Confidence Coefficients and the Burden of Persuasion*, 73 CORNELL L. REV. 54, 72 (1987) (arguing that for purposes of civil suits, false negative beliefs formed on the basis of statistical evidence are just as troubling as false positive beliefs). The use of a "more probable than not" standard for civil cases implies that the law is neutral between the risk of false positives and false negatives. Science, on the other hand, is far more concerned with false positives than it is with false negatives. *See, e.g., id.* at 68 (observing that the requirement of statistical significance to 95% confidence creates a much higher risk of false negatives than false positives). The customs of epidemiology eloquently demonstrate science's asymmetrical worries. Epidemiology generally requires a 5% risk of error or better for those arguing against the null hypothesis, but the risk of error is only required to be less than 20% for those arguing for the null hypothesis. *See* Farrell, *supra* note 94, at 2210-11.

122. *See* DeLuca v. Merrell Dow Pharms., Inc., 911 F.2d 941, 947-49 (3d Cir. 1990) (discussing the proper level of statistical significance for statistical evidence to be admissible and calling into question blind adherence to the 5% standard).

123. FED. R. EVID. 401. *See also* Farrell, *supra* note 94, at 2211 (arguing that legal concerns should dictate the level of statistical significance required for evidence to be admissible, not scientific concerns); Lempert, *supra* note 119, at 1095 (same); Poulter, *supra* note 79, at 261 (arguing for use of a 50% confidence level for legal purposes).

notion of causation, victims could only recover if the accidents that injured them were of the type whose incidence is expected to double due to climate change.[124] Only if the incidence of say, tornadoes, doubled as a result of climate change would it be possible to claim that it was more probable than not that a particular tornado was "caused" (in the deterministic sense) by climate change.

If courts were to adopt a probabilistic conception of causation, however, victims of any type of accident whose likelihood increased as a result of climate change would be able to recover something. Causation could be established by evidence indicating that climate change merely increased the risk of the type of harm suffered by the plaintiffs. Plaintiffs would not, however, be required to show that, more probably than not, their injury was somehow mechanistically caused by climate change. Thus, plaintiffs would have a claim even if, as will likely often be the case, the risk of the type of accident from which they suffered did not actually double.[125]

2. The Goals of Tort Law and Deterministic Causation

Calabresi has rightly pointed out that the question of causation in tort law is not simply a philosophical issue, and so must not only be scrutinized for philosophical validity, but also explored in terms of the

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124. *See supra* note 91. *See also* David E. Bernstein, *The Admissibility of Scientific Evidence After* Daubert v. Merrell Dow Pharmaceuticals, Inc., 15 CARDOZO L. REV. 2139, 2167-71 (1994) (arguing that an RR greater than 2.0 should be required for statistical evidence of causation to overcome a motion for summary judgment by the defendant).

125. Such a rule would also require changes in the rules of evidence that have been adopted in several jurisdictions. In the Ninth Circuit, for example, a plaintiff must demonstrate an RR greater than 2.0 in order to have statistical evidence admitted at trial. *See* Daubert v. Merrell Dow Pharms., Inc., 43 F.3d 1311, 1321 (9th Cir. 1995). Since the Supreme Court's decision in *Daubert v. Merrell Dow Pharms., Inc.*, 509 U.S. 579 (1993), which established the standard for the admissibility of scientific evidence under Rule 702 of the Federal Rules of Evidence, lower courts seem to have taken a much more stringent approach to the admissibility of scientific evidence in toxic tort cases in general. *See* Bernstein, *supra* note 124, at 2139 (citing O'Connor v. Commonwealth Edison Co., 13 F.3d 1030 (7th Cir. 1994); Elkins v. Richardson-Merrell, Inc., 8 F.3d 1068 (6th Cir. 1993), *cert. denied*, 510 U.S. 1193 (1994); Thomas v. American Cyanamid, 7 F.3d 235 (6th Cir. 1993); Porter v. Whitehall Labs, Inc., 9 F.3d 607 (7th Cir. 1993); De Luca v. Merrell Dow Pharms., Inc., 6 F.3d 778 (3d Cir. 1993), *cert. denied*, 510 U.S. 1044 [1994]). *But see* Anthony Z. Roisman, *The Courts, Daubert, and Environmental Torts: Gatekeepers or Auditors?*, 14 PACE ENVT'L L. REV. 545, 552 (arguing that courts have interpreted *Daubert* as liberalizing the rules for admissibility of scientific evidence). If, however, courts were to change their approach to causation and move towards a probabilistic notion, statistical evidence indicating an RR of less than 2.0 would provide relevant evidence of causation and would have to be admitted under the *Daubert* standard.

goals of tort law.[126] More important than metaphysical accuracy, Calabresi argues, is whether the notion of "cause" in tort law allows human beings effectively to control the frequency of accidents in the ways suggested by the goals of tort theory.[127] Thus, in addition to criticizing the *but for* requirement in toxic torts from the position of philosophical validity, it is necessary to consider the extent to which it serves the two goals of tort law discussed above in Part III.

a. Reducing the Costs of Accidents

Given the fact that most toxic torts rely upon statistically based evidence to prove causation, it is easily demonstrated that the *but for*, deterministic notion of causation frustrates the goal of reducing the costs of accidents by internalizing the costs to the actors in the best position to carry out the cost-benefit analysis between accidents and accident prevention.[128] An example will demonstrate why this is the case. Imagine a situation in which three factors (for example, smoking, asbestos, and air pollution) all contributed to a single effect (for example, lung cancer), that also occurred naturally (that is, among people who were not exposed to any of the three suspect factors). Pretend that each cause raised the chances of acquiring lung cancer by 40 percent. The plaintiff in this hypothetical is a long-time smoker who has also been repeatedly exposed to asbestos and air pollution.

If courts adhered rigidly to the rule that a plaintiff must demonstrate, more likely than not, that *one* of the indicated factors caused his case of cancer (rather than any of the others, or rather than being one of the background cases that would have occurred anyway), then the plaintiff will not be able to recover at all (indeed, he would not be able to recover even if each factor more than doubled the risk of lung cancer vis-à-vis the background risk). As a result of this failure to recover (barring some regulatory action by the state, and assuming that, as in the real world, victims do not have perfect knowledge and cannot easily organize to pay producers to make products safer), cancers caused by these three factors will likely stand as externalities. Because people will over-consume the products in question (asbestos, cigarettes, and products causing air

126. *See* Calabresi, *supra* note 112, at 105 (arguing that law is a human construct designed to fill human needs, and that therefore "many seemingly philosophical questions concerning cause become irrelevant to the use of that term in law").

127. *See id.*

128. *See id.* at 86-87 (arguing that *but for* causation should not be rigidly adhered to when it is difficult to prove, such as when there are multiple defendants whose actions combine to cause a single effect).

pollution), these externalities will produce significant misallocation costs.[129]

The same problem occurs if one of the causal factors (say, cigarettes) predominates over the others such that a plaintiff who is exposed to all three has a 60 percent chance of having acquired his cancer from cigarettes, as opposed to asbestos, air pollution, or background causes. In this situation (ignoring issues of contributory negligence), everyone exposed to cigarettes who develops lung cancer will be able to recover from tobacco companies, and no one will be able to recover from asbestos companies or producers of air pollution. Cigarette producers would have to pay for all the cases of lung cancer among the exposed group, even though cigarettes are really only responsible for 60 percent of the cases of lung cancer in that group. For the same reason as above, from the point of view of economics, the result will be an inefficient burdening of cigarette manufacturers and overconsumption of the other products, with the corresponding misallocation costs.

Thus, the all-or-nothing approach to causation mandated by mechanistic notions of *but for* cause fails to serve the goal of accident cost reduction in the case of toxic torts, where only statistical evidence over large populations is available. The solution is therefore to allow for recovery even when a causal factor causes a particular effect less than 50 percent of the time.[130] The problem with this solution is that it seems to violate notions of fairness that stand behind the second goal of tort law.

b. Corrective Justice

Notions of justice in tort law are often considered to operate at the level of individuals.[131] Thus, awarding damages to a plaintiff who failed to

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129. From the perspective of economics, the result will be too many lung cancer cases. *See, e.g.*, POLINSKY, *supra* note 46, at 97-99 (arguing that the failure to internalize the costs of accidents in the real world of positive transaction costs leads to overconsumption of the product and therefore too many accidents).

130. *See* Cottle v. Superior Ct., 3 Cal. App. 4th 1367, 1401-02 (1992) (Lillie, J., dissenting) (arguing that application of traditional causal conceptions to toxic torts will lead to undercompensation of some plaintiffs and overcompensation of others). Judge Lillie insightfully critiques the traditional understanding of causation:

> The old rules of causation simply don't work—because toxics are not automobiles or the other instruments of sudden destruction so familiar to the law. Toxics operate at a microscopic, often submicroscopic, level. They also typically do their damage over the course of months or years. Consequently, there are no witnesses to the "events" linking the toxic to its victim—no one to say I saw this toxic invade this cell and chemically alter its composition so that a dozen cell generations later it mutated into a cancer that then grew larger and larger until it now threatens the patient's life.

Id.

131. *See* David Rosenberg, *The Causal Connection in Mass Exposure Cases*, 97 HARV. L. REV. 849, 858 (1984).

prove, more likely than not, that a given defendant caused his particular injury seems to some to violate the principles of corrective justice that underlie tort law.[132] But such a conclusion ignores the nature of toxic torts.

Because of the complex and drawn out nature of the causal problem in toxic torts, the question of whether or not a particular causal factor caused (in the mechanistic sense) a particular case of disease is one to which no possible answer can be given. We simply cannot know whether smoking caused this particular case of lung cancer.[133] From the perspective of the plaintiff, then, requiring him to answer a question that is unanswerable in order to recover seems particularly unjust. Further, as Rosenberg observes, the effect of forcing the plaintiff to answer this question is to shield clear wrongdoers from liability and to place the full cost of the victim's injuries on the victim himself.[134] From the perspective of the plaintiff, at least, it is not the rejection of the notion of *but for* causation, but its requirement, that is a source of injustice.

From the perspective of the defendant, two arguments for the injustice of foregoing the notion of *but for* causation present themselves. First, a defendant would likely argue that it is unfair to hold him responsible for an injury to an individual plaintiff that he might not have caused. As discussed above, however, this argument ignores the nature of toxic torts, which makes proof of such individual causation an impossibility. Thus, for the plaintiff to recover from the defendant without having proved something that cannot be proven can hardly be said to be unfair to the defendant, who is undoubtedly responsible for *some* injuries. If the heart of the justice goal in tort law is reflected in the notion that victims should be compensated and injurers should pay, then it does not seem to matter that the two are not *necessarily* joined to each other in the same proceeding.[135]

A second argument by the defendant would be more sound, however. The defendant could argue that it would be wrong for him to be held liable in cases where the plaintiff could not prove specific causation, because then the defendant could be held liable to all exposed plaintiffs who suffer from the same injury, even though the scientific evidence only

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132. *See, e.g.*, Black & Lilienfeld, *supra* note 90, at 765 ("The finder of fact must decide whether it is more likely than not that an individual plaintiff contracted a specific disease as a result of exposure to a factor for which the defendant is legally responsible.").

133. *See* DUPRE, *supra* note 34, at 182.

134. *See* Rosenberg, *supra* note 131, at 879.

135. This idea that particular victims need not necessarily be joined to particular injurers is exemplified by Coleman's proposal for a system whereby victims of auto accidents would be fully compensated, even if their injurer could not be identified. This would be accomplished by giving demerits to people who drive negligently, and then charging them periodically for the costs of uncompensated victims according to the number of their demerits. *See* Jules L. Coleman, *On the Argument for the Fault System*, 71 J. PHIL. 473, 484-85 (1974).

indicates that he is responsible for x percent of the cases of that injury. This objection, although certainly sound, goes to the issue of the *extent* of the defendant's liability, rather than to the fact of liability itself, the issue of concern here. Suffice it for now to say that theories of proportional liability (that is, where the defendant is held liable for only a portion of the plaintiff's damages in proportion to his causal contribution to injuries of the plaintiff's type) would resolve this objection.[136]

B. Determining Who Should Pay and How Much

1. *Two Splitting Rules*

The foregoing discussion of the extent of the defendant's liability leads naturally into a discussion of the second major problem with a tort analysis of global climate change: determining the specific identity of the responsible parties and how much they should pay. As was discussed above in Part III, the cost-reducing goal of tort law indicates that courts should seek to hold liable those parties who are in the best position to make the price of products that lead to global climate change reflect their true costs (that is, to include the costs of accidents produced by global climate change within the prices of products whose manufacture and use contributes to the problem of climate change). The second, justice-based, goal of tort law indicates that the parties held liable should be those who have negligently failed to address the threat of climate change and who have taken actions to prevent other people from dealing appropriately with this threat.

Given these goals, it is justifiable to hold liable the companies located at the earliest stages in the process of producing and marketing the fossil fuels resulting in greenhouse gas emissions. By holding fossil fuel companies liable, the prices of all products dependent upon greenhouse-gas producing processes will be affected as well.

Because of the concentration in the energy markets, this allocation of liability will not entail an unwieldy number of players. Just 15 companies, for example, account for 91 percent of the American market for gasoline, the largest market in the world.[137] In the coal industry, just 11

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136. *See* Robinson, *supra* note 61, at 781. Of course, such theories would entail substantial administrative burdens. The repeated resolution of the defendant's precise liability would be both expensive and inefficient. Such concerns should be addressed, however, when considering the proper method of administering tort-based claims for damage caused by climate change. For a brief discussion of the issues involved in administering claims for climate change injuries, see *infra* Part IV.C.

137. *See Mobil Edges Shell as top Gasoline Marketer*, NAT'L PETROLEUM NEWS, Aug. 1996, at 136. The top ten oil companies control over 75% of the American market. *See id.* By way of comparison, in the DES litigation, the plaintiffs alleged that 6 or 7 companies accounted for

companies account for over two thirds of American output, which is second only to China.[138] This concentration in the coal industry is expected to increase in the future.[139] But once it is determined that oil, natural gas, and coal companies (and possibly companies responsible for deforestation) can and should be held liable for the costs produced by global climate change, it becomes necessary to develop a theory by which the liability of each individual actor can be allocated.

Two liability-splitting rules seem particularly appropriate in making this determination. The first is the theory of market-share liability, a theory that developed in the context of mass torts and was first applied in the di-ethyl stilbestrol (DES) litigation.[140] Applied to the context of global climate change, defendants would be held liable for damages in the same proportion as their share of the global market for fossil fuels. This could be accomplished by giving each fossil fuel a CO_2 equivalent value. The carbon equivalents of all fossil fuels produced worldwide would be totaled, and defendants would be held liable for damages caused by global climate change in the same proportion as their share of the global CO_2 market. If one defendant were responsible for producing and selling 5 percent of the world's CO_2 equivalent in fossil fuels, it would be responsible for 5 percent of the costs of global climate change.[141]

A second liability-splitting rule would also be required. As discussed above in subsection IV.A.2.b, it would be unfair to hold a defendant responsible for all instances of an injury that its product caused only some of the time, although there is no way to determine which

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90% of the DES market in the United States. *See* Sindell v. Abbott Laboratories, 607 P.2d 924, 937 (Cal. 1980).

138. *See U.S. Coal Mining Analysed*, THE MINING JOURNAL, July 12, 1996, at 29. The trend towards greater concentration can be seen in the fact that in 1976, the top 11 companies controlled just 39% of the market. *See id.*

139. *See id.*

140. *See* Sindell v. Abbott Laboratories, 607 P.2d 924, 937 (Cal. 1980) (holding DES manufacturers liable for injuries caused to a class of plaintiffs in proportion to their share of the DES market). *See also* Hymowitz v. Ely Lilly & Co., 539 N.E.2d 1069, 1076 (N.Y. 1989) (adopting the market share theory for DES liability).

141. A complicating factor is raised by the long lifespan of many greenhouse gases in the atmosphere. As a result of this lifespan, past emissions have a cumulative effect on the climate change problem. Thus, current producers of fossil fuels would, under this article's proposal, be held liable for damage produced by CO_2 they did not have a role in emitting. From the standpoint of efficiency, this result is not anomalous, since the ability to internalize the costs of climate change is all that matters (not historical role in emitting CO_2 into the atmosphere). From the standpoint of justice, however, this result may be problematic. One important fact, however, mitigates the unfairness of using current market share as a proxy for overall CO_2 production. The upward spiral in global CO_2 emissions over the course of the 20th century means that emissions from the latter part of the century have played a much larger role in producing the specter of climate change than those from the earlier part of the century.

particular injuries it caused. Thus, relaxing the causation requirement in toxic torts would only be consistent with principles of corrective justice if it were coupled with a simultaneous adoption of a rule of proportional liability.[142] Under a system of proportional liability, the defendant's total liability, determined according to a market share theory, would be discounted by its percentage of causal contribution to the total occurrence of the injury in question. Thus, if it were determined with a high degree of certainty that anthropogenic climate change was responsible for a 100 percent increase in hurricane damage on the west coast of the United States, an individual defendant's liability for damage caused by hurricanes on the west coast would be discounted 50 percent to account for the fact that half the hurricanes on the west coast would have occurred even without climate change, although it is impossible to know which half.

The above examples are obviously idealized cases. In the real world, the exact contribution of anthropogenic climate change to a given climatic event is likely to be highly uncertain. Different models will likely produce somewhat widely varying diagnoses. Further, the factor of statistical significance also has a role to play in assessing the contribution of climate change. If, for example, climate models predicted a 100 percent increase in hurricane damage, but with only a statistical significance equivalent to 80 percent confidence, the contribution of climate change would probably be somewhat less than 50 percent.[143] Although these statistical subtleties can be quite confusing, they are not irresolvable. Their complexity, however, does indicate the wisdom of an administrative approach toward the calculation of liability for climate change injuries.[144]

2. The Problem of Time Lags

A second problem with determining how much liable parties should pay for damage caused by climate change is presented by the observation that many of the most serious consequences of climate change are not likely to occur until the second half of the next century, while the actions that will lead to those consequences are taking place right now.[145] Most methods of discounting for present value lead future damages to

142. *See* Cottle v. Superior Ct., 3 Cal. App. 4th 1367, 1403-04 (1992) (Lillie, J., dissenting) (advocating the adoption of a rule of proportional liability in toxic torts). *See also* Robinson, *supra* note 61, at 781.

143. *See, e.g.*, Merrell Dow Pharms., Inc., v. Havner, 953 S.W.2d 706, 718 (Tex. 1997) (discussing the effect of statistical significance on the overall estimate of a factor's causal contribution to the frequency of a certain phenomenon).

144. See *infra* Part IV.C for a discussion of the factors weighing in favor of an administrative approach.

145. *See* Ian W.H. Parry, *Some Estimates of the Insurance Value Against Climate Change from Reducing Greenhouse Emissions*, 15 RESOURCE & ENERGY ECON. 99, 99-100 (1993).

have negligible present value simply because they take place so far in the future.[146] This time lag and its effect on present day policy raise serious issues of "intergenerational equity."[147] The implications of climate change for future generations suggest that a very conservative discount rate should be used in calculating the present value of future damage caused by global climate change.[148] It seems plausible, as a general principle, that the present generation should not seek speculative value based on risks delayed to the next generation. That would be much like gambling with someone else's money. In the case of climate change the imperative toward conservatism is even stronger, because the risks involved are so great, going as they do in some worst-case scenarios to the very livability of the planet for human society.

Further, because the application of tort principles to climate change seeks to induce behavior that will minimize the damage caused, some mechanism must be devised by which fossil fuel companies can in the near future be forced to make the price of their products reflect their true costs. In other words, in order to prevent many disasterous effects of climate change, some way must be devised for bridging the gap between present decisions of fossil fuel consumers and the damage that will be caused by those decisions in the future. Of course, such a goal would require

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146. *See id.* As Daniel Esty observes, this time delay is probably at least in part to blame for the present lack of political resolve in dealing with the issue of climate change. *See* Daniel C. Esty, *Revitalizing Environmental Federalism*, 95 MICH. L. REV. 570, 573-74 (1996).

147. *See id.* at 599.

148. *See* WILLIAM R. CLINE, THE ECONOMICS OF GLOBAL WARMING (1992) (calling for a social discount rate of zero, a choice that results in a goods discount rate of 1.5%). The subject of the proper discount rate for cost benefit analyses with long time horizons has troubled economists for many years. As far back as 1928, economist F.P. Ramsey argued that a social discount rate (i.e., a preference for benefits now over benefits later, purely on the basis of a time preference) greater than zero was unethical. *See* Duane Chapman et al., *Rolling Dice for the Future of the Planet*, 13 CONTEMP. ECON. POL. 1, 6 (1995). John Rawls concurs in this opinion. *See* JOHN RAWLS, A THEORY OF JUSTICE § 45 at 293-94 (1971). This position is also shared by Tyler Cowen, who argues that consequentialist reasoning requires a social discount rate of zero. *See* Tyler Cowen, *Consequentialism Implies a Zero Rate of Intergenerational Discount*, *in* JUSTICE BETWEEN GROUPS AND GENERATIONS (Peter Laslett & James S. Fishkin eds., 1992). Nordhaus, on the other hand, argues for a positive social discount rate of 3%. *See* WILLIAM D. NORDHAUS, MANAGING THE GLOBAL COMMONS: THE ECONOMICS OF CLIMATE CHANGE 124 (1994). Although Nordhaus argues that the selection of a social discount rate is fundamentally empirical, *see id.* at 125, the issue seems to be far more ethical in nature. *See* Tyler Cowen & Derek Parfit, *Against the Social Discount Rate*, *in* JUSTICE BETWEEN GROUPS AND GENERATIONS, *supra*, at 146 ("It *is* a moral question how much weight we ought to give the interests of [people not yet born]."). The choice of a discount rate has a profound impact on the final assessment of the present value of the harms that will possibly result from climate change. *See* Chapman et al., *supra*, at 6 ("Not only does [a lower discount rate] translate into a greater level of action, but also a greater urgency.").

assessing the fossil fuel companies according to their risk creation instead of merely assessing them for harm already done.[149]

One way this could be achieved would be for the body charged with calculating liability to estimate the costs of the risks associated with climate change on an incremental basis. That is, the body could calculate the cost of climate change under varying CO_2 levels. Each year (or on some other periodic basis), the "new" (future) costs of climate change, based on CO_2 added to the atmosphere since the previous assessment, could be calculated and charged to the defendant. The money would not be used immediately to compensate individuals for their added risk, however. Instead it could be deposited in an insurance fund that would be used to compensate victims of the types of events likely to increase in frequency and severity as a result of global warming.[150] Alternatively, the money could be used to reimburse insurance companies for their losses due to global climate change.

3. Damage to Public Goods

Another obstacle to the correct calculation of the costs of global climate change is presented by damage to "public goods" or shared environmental resources. Damage to oceanic life, for example, could amount to an enormous externality if it were not somehow incorporated into an assessment of damages caused by greenhouse gas emissions. Any such damages should be monetized to the extent possible and included in the estimate of liability for climate change. Money collected as a result of such damage could be used to attempt to mitigate the damages to such public goods.

4. The Problem of Reductionism

On the other hand, it might be argued that damage to shared environmental resources may reflect an area where a tort analysis is not useful and a more direct governmental approach becomes necessary. This is because some harms cannot, or perhaps should not, be reduced to money. As Radin points out, assigning monetary values to certain goods can be inappropriate, such moral reductionism being incompatible with their "market inalienable" value.[151] Intrinsic, market-inalienable value

149. *See* Robinson, *supra* note 61, at 786-87.

150. This idea is derived from Rosenberg's proposal for "insurance fund judgments" in toxic tort cases. *See* Rosenberg, *supra* note 131, at 919.

151. Margaret Jane Radin, *Market-Inalienability*, 100 HARV. L. REV. 1849 (1987). *See also* BERNARD WILLIAMS, MORALITY: AN INTRODUCTION TO ETHICS 94-97 (1972) (discussing the problem of reductionism inherent in purely utilitarian thinking, of which welfare economics is a typical example). Williams argues that Utilitarianism oversimplifies our moral experience in order to develop a moral currency that is comparable and additive, conditions necessary

might be attributed to certain shared environmental resources.[152]

This objection may have more validity against completely economic approaches to climate change (or environmental problems in general) than against a tort-based approach such as the one laid out in this article.[153] Some scholars, such as Richard Posner, have advocated a purely economic theory of tort liability, but the one I have described includes notions of moral responsibility. Including as it does such symbolic features as stigmatization of negligent injurers and vindication of innocent victims, a mixed system of tort liability is capable of going beyond a mere market valuation of accident costs. Hence, there is less danger of the problem of reductionism in a tort approach to climate change than there is in, say, a purely economic approach such as the one endorsed by Nordhaus.[154]

C. Administering a System of Tort Liability for Climate Change

The final major problem with a tort approach to global climate change would be devising a system for administering the enormous number of claims that will almost certainly result. Administrative costs are part of the total cost of accidents and accident avoidance.[155] Thus, all things being equal, it is necessary to try to minimize the administrative costs involved in transferring money from injurer to victim in accordance with the principles of justice.

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in order to accomplish the "cost benefit analysis" required by utilitarian decision-making. *Id.* at 94, 97. In a devastating critique of utilitarian thinking, Williams says, "[Utilitarians] might say that they were not committed to the view that the common currency of happiness is money. But they are committed to something which in practice has those implications. . . . [U]tilitarianism is unsurprisingly the value system for a society in which economic values are supreme." *Id.* at 96-97. For a more nuanced criticism of Utilitarianism's inability to capture the complexity of our moral experience, see Williams's essay in J.J.C. SMART & BERNARD WILLIAMS, UTILITARIANISM: FOR AND AGAINST 77-150 (1973).

152. *See, e.g.*, Carol M. Rose, *Givenness and Gift: Property and the Quest for Environmental Ethics*, 24 ENVT'L L. 1, 12-14 (1994) (discussing the need to consider the ethical and spiritual value of environmental resources, and suggesting an approach whereby environmental resources are analyzed to some extent as "gifts.").

153. *See also* Coleman, *supra* note 62, at 357. *Cf.* Perry, *supra* note 61, at 450 ("I do not rule out the possibility in advance that a kind of moral pluralism prevails within the institution of tort law. This might mean, for example, that pure principles of reparation are balanced against, or at least qualified by, norms of economic efficiency.").

154. *See* W.D. Nordhaus, *A Sketch of the Economics of the Greenhouse Effect*, 81 AMER. ECON. REV. 146 (1991).

155. *See* CALABRESI, *supra* note 36, at 225 ("Once it is decided that a particular system of accident law will be used, the expenses of administering that system can be viewed simply as accident costs.").

Case by case adjudication is commonly acknowledged to be an extremely expensive means of compensating the victims of accidents.[156] In mass torts, the complexity of the issues and the number of parties involved seems to exacerbate this administrative problem. In the asbestos litigation, for example, administrative costs (primarily in the form of attorney fees) represented 60 percent of the total costs.[157] Moreover, as Esty argues, the more dispersed the causes and impacts of environmental harms, the less likely individuals will be able to assert their rights through common law, judicial processes.[158] The large number of (often small) claims involved in global climate change liability implies the appropriateness of a non-judicial administrative process.

Erroneous results should also be viewed as administrative costs.[159] For this reason, the complexity of the scientific and statistical issues involved in toxic torts has led some scholars to propose alternative mechanisms for resolution of toxic tort litigation. Troyan Brennan, for example, has called for the creation of "science courts" that would evaluate scientific evidence in toxic tort cases.[160] The same scientific complexity that caused Brennan to propose such specialized courts would be present in litigation concerning global climate change. Fact finders in a climate case would be called upon to assess the validity of competing climate models, whose differences depend upon arcane issues of statistics and atmospheric science.[161] Rather than juries, or even a special system of courts, the scientific complexity of those claims would suggest the appropriateness of an agency approach to the administration of climate change claims. Such an agency would be better able to gather the relevant information and to develop the requisite expertise for assessing the issues at the heart of climate-change liability.[162]

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156. *See, e.g., id.* at 161; E. Donald Elliot, *Why Courts? Comment on Robinson*, 14 J. LEGAL STUD. 799, 801-02 (1985).

157. *See id.* at 802.

158. *See* Esty, *supra* note 146, at 580.

159. Such costs are analogous to what, in the regulatory realm, Esty calls "technical welfare losses." *See id.* at 585.

160. Brennan, *supra* note 81, at 526. Justice Breyer has also called for the use of similar science experts. *See* STEPHEN BREYER, BREAKING THE VICIOUS CIRCLE: TOWARD EFFECTIVE RISK REGULATION (1993).

161. Different climate models can yield extremely different results in terms of projected costs of global climate change. *See, e.g.*, Stevens, *supra* note 28; CLIMATE CHANGE 1995 tbl. 6.3 at 298-99 (listing a series of climate models and their different conclusions regarding the likely rise in global mean temperature given a doubling in atmospheric CO_2).

162. An agency like the one that would be responsible for administering the claims associated with climate change liability resembles to some extent the "National Institute for the Environment" proposed by Professor Esty. *See* Esty, *supra* note 146, at 622.

An administrative solution would take the form of a congressional declaration of liability on the part of fossil fuel companies and the establishment of the proper administrative mechanism for calculating and transferring monetary damages from these companies to those who suffer from the accidents caused by climate change. In its general form, this would not be unprecedented. Worker's compensation functions along similar lines, with companies paying into a general fund that is used to compensate injured employees.[163] Similarly, the proposed congressional tobacco settlement represents a legislative resolution of what is essentially a giant tort.

This is not to say that an agency would not create administrative costs of its own. Unlike courts, which already exist, an agency would have to be built up from scratch. Offices, equipment, and a staff of full-time experts and claims adjusters would require a substantial outlay of resources.

Further, the nature of legislatively created administrative agencies renders them far more sensitive to political pressures than a relatively independent judiciary.[164] Thus, an administrative solution would have to find a way to insulate the agency from such outside interference. Nevertheless, compared with the potentially enormous administrative costs involved in a judicially managed system, a specialized agency would be the best means of administering climate change liability. Because an administrative solution would depend upon congressional action for its creation, however, it suffers from some of the same weaknesses that affect other proposed solutions to the problem of climate change.[165]

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163. *See, e.g.*, Daniel L. Driscoll & Judge Raymond P. Green, *Workers' Compensation: Proposed Cures for Runaway Costs*, N.Y. STATE BAR J., Dec. 1996, at 36. Of course, worker's compensation suffers from a great many weaknesses, but these is no reason to think that these are essential to an administrative tort response.

164. *See* Esty, *supra* note 146, at 633 (discussing the susceptibility of environmental rulemaking to political manipulation by polluters with money). Similar claims have been made about the political manipulability of other federal agencies, such as the FAA and the EPA. *See, e.g.*, Robert M. Hardaway, *Transportation Deregulation: Turning the Tide*, 14 TRANSP. L.J. 101, 149 (1985) (discussing the FAA's susceptibility to political pressure); David M. Driesen, *Five Lessons from the Clean Air Act Implementations*, 14 PACE ENVTL. L. REV. 51, 59 (1996) (arguing that EPA susceptibility to political pressures has made efficient enforcement of environmental statutes difficult).

165. Given sufficient congressional inaction, it might be incumbent upon the judicial branch to take on the problem of tort liability for climate change and possibly to create an institutional system, based upon Rosenberg's public law model of judicial action, for administering claims based upon such liability. *See, e.g.*, Rosenberg, *supra* note 131, at 907. Such institutions have been created in the past to deal with the administration of toxic tort settlements. *See also, e.g.*, Peter H. Schuck, *Mass Torts: An Institutional Evolutionist Perspective*, 80 CORNELL L. REV. 941, 985 (1995). Schuck provides an alternative perspective on the issue of the proper mechanism for administering mass tort claims. He believes that the judicially

V. CONCLUSION

Considering the current deadlock over the best way to deal with the problem, tort law does present a useful methodology for analyzing the problem of how to allocate the costs produced by global climate change. Although it is certainly not the only necessary policy response, addressing the issue of who will bear what are likely to be quite substantial costs from climate change would reflect an important step in the right direction. Further, knowledge that they will have to bear the costs of damage produced by climate change, even without actual assessments, would seem likely to change what up to now has been the primarily obstructionist role played by fossil fuel companies. Potential liability for future damages caused by climate change has made the insurance industry one of the leaders in the call for attention to the issue of climate change.[166] Perhaps by making fossil fuel companies responsible for the damage caused by their products, a change in their attitude can be brought about. Rather than using their resources to block any action on fossil fuel, companies might, like the insurance industry, move to the forefront of those seeking to take action now to minimize the damage caused by climate change.

An administrative, tort-based solution to the costs of climate change would also work well in conjunction with one of the most popular of the current proposals for reducing CO_2 emissions, the carbon tax. Discussions of the carbon tax often fail to discuss the question of compensation to those who will suffer harms as a result of climate change.[167] The logic of the foregoing analysis indicates that any tax on carbon should be used at least in part to compensate the victims of climate change induced accidents.

A tort-based solution would differ from a straight carbon tax in an important way, however. The application of a tort remedy would send a clear message that fossil fuel producers will bear the costs of the damages produced by climate change. The logic of tort liability will provide fossil fuel companies with the incentive to market their product in a way that will

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administered system compares favorably with its alternatives of a market in tort claims or a legislatively-created agency like the one I think would function most efficiently. *See id.* at 980.

166. *See, e.g.*, Christopher Adams & Leyle Boulton, *Insurers Call for Emission Curbs*, FIN. TIMES, Dec. 5, 1997, at 4 (describing insurance companies' concerns over future costs of global climate change for which they will have to pay).

167. *See, e.g.*, Sterner, *supra* note 47 (describing the economic argument for a gasoline tax, but failing to consider the compensation of victims); Peter Hoeller & Markku Wallin, *Energy Prices, Taxes and Carbon Dioxide Emissions*, OECD ECON. STUD., Autumn 1991, at 91 (describing a carbon tax without discussion of payments to victims of accidents caused by climate change).

minimize their losses due to climate change. An invariable carbon tax, unconnected to the actual environmental damage produced by fossil fuels, would fail to have such an incentive-modifying effect.

Further, the rhetoric of tort liability might make the notion of a carbon tax more palatable to the general public.[168] Taxes have become hard to sell to the American public. Requiring companies to pay for the harms caused by their products, however, would fall outside of the rhetoric of "taxation" and perhaps thereby escape the hostility associated with such proposals.

Money collected from fossil fuel producing industries should be put into an insurance fund and drawn upon to compensate the victims of accidents identified as the types of accidents likely to increase in frequency as a result of global climate change. Money might also be spent to shore up insurance companies put under pressure by increased claims on their property and casualty policies as a result of climate change or to help people in hard-hit regions pay for higher insurance premiums caused by increased risk of damage.

Finally, the global nature of the climate-change problem indicates that the mechanism created to deal with its costs should be potentially global in its scope. That is, it should be able to collect damages from companies operating worldwide. Further, it should be able to disburse money to victims of accidents, regardless of whether or not they are in the United States. Perhaps a mechanism like the one I have proposed could be administered internationally in order to provide the jurisdictional scope necessary to avoid problems of "structural mismatches."[169] Clearly, the need to internationalize any solution to climate change represents an

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168. *See* Strauss & Urquhart, *supra* note 40, at 221-22 (arguing that the only way to successfully implement a tax on energy is "to make the case on environmental grounds.").

169. Esty, *supra* note 146, at 587. Tort principles may provide a useful means of analyzing the arguments of developing countries that they should not have to pay for more expensive, non-greenhouse-gas-producing energies, because developed nations were able to develop using "cheap" fossil fuels. The tort analysis used in this paper suggests that one way to resolve this dispute would be to divide the costs of climate change among nations according to their contribution to the anthropogenic climate change currently in the atmosphere. At this aggregated level, an "historical" approach (as opposed to a current market share approach), *see supra* note 115, to measuring CO_2 emissions seems feasible. Of course, this "historical" approach should also be prospective, because projected future greenhouse gas emissions from developing countries contribute to the damage predictions that would be used in forecasting the costs of climate change. To some extent, however, this tort analysis is a separate issue from what is essentially a question of distributive justice raised by many developing nations. *See, e.g., Around the Globe, Big Worries and Small Signs of Progress*, N.Y. TIMES, Dec. 1, 1997, at GW9 ("[Developing] nations have said that it is up to the United States and other Western nations to cut back on emissions without imposing similar requirements on poorer countries that are trying to catch up economically with the West.").

enormous challenge to the effective formulation of a tort-based policy. The complexities raised by this challenge go beyond the scope of this article, however. In any event, the enormous contribution of the United States towards the problem of CO_2 emissions and the huge costs likely to be suffered by people living within the United States means that even a purely internal mechanism would reflect a significant contribution to a climate-change solution.[170]

170. *See* Lynch, *supra* note 72, at 16 (citing the United States as the largest gross emitter of CO_2 as well as the largest per capita emitter).