SUFFOLK UNIVERSITY
LAW REVIEW

VOLUME XLIII 2010 Number 4

Carbon Dioxide: Our Newest Pollutant

Richard A. Epstein[1]

I. WHY CARBON DIOXIDE?

It was my great pleasure to come to Suffolk University Law School to join the ranks of the many distinguished individuals who have delivered the Donahue Lecture. The topic of this lecture is the simple chemical, carbon dioxide, which is, now officially, our newest pollutant. The first question to ask is why I chose this particular title for carbon dioxide, a substance that predates the industrial revolution and is, in limited quantities at least, necessary for the survival of life as we know it on this planet. The answer relates to complexities that lie beyond my control under the peculiar statutory framework for dealing with pollutants under the Clean Air Act (CAA), which is administered by the Environmental Protection Agency (EPA). Pollutants must be registered under the CAA, and there has been a huge dispute—which I shall explain later on—about whether or not carbon dioxide should be registered as such under the Act.[2] After much internal debate, the Bush Administration said no. The states, led by Massachusetts, thought that the answer ought to have been yes. They forced the issue to the Supreme Court, which held in

1. Laurence A. Tisch Professor of Law, New York University School of Law; Peter and Kirsten Bedford Senior Fellow, The Hoover Institution; and James Parker Hall Distinguished Service Professor of Law, The University of Chicago. This lecture was delivered on November 5, 2009 at Suffolk University Law School. In preparing the lecture for publication, I have updated it to take into account the major events that have occurred following its delivery.

2. "The [EPA] Administrator shall by regulation prescribe (and from time to time revise) in accordance with the provisions of this section, standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare." Clean Air Act § 202(a)(1), 42 U.S.C. § 7521(a)(1) (2006).

Massachusetts v. EPA[3] that, although the EPA was not necessarily bound to make that "endangerment" determination, it was nonetheless authorized to do so because carbon dioxide fell within the CAA's definition of an "air pollutant."[4] Under the CAA, an "air pollutant" is "any physical [or] chemical . . . substance or matter which is emitted into or otherwise enters the ambient air."[5]

In a world of small coincidences, one of my former students, Liza Heinzerling, has played an active role in this debate. She was a lead author of the plaintiff's brief in *Massachusetts v. EPA*, and is now a key member of the Obama Administration's climate change team at the EPA.[6] Lo and behold, the position of the Bush Administration has been reversed as Lisa Jackson, the head of the EPA, has made an endangerment finding on carbon dioxide, as well as five other greenhouse gases (GHGs)—methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (HF_6). This finding has paved the way for their regulation under the CAA, which imposes extensive regulatory schemes on emissions from both stationary and moving sources.[7] The people who once litigated from the outside, through

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3. 549 U.S. 497 (2007).

4. *See id* at 528-29, 534-35 (holding carbon dioxide constitutes "air pollutant," but reserving question whether EPA endangerment finding required).

5. 42 U.S.C. § 7602(g) (2008). In full, the CAA defines "air pollutant" as follows:

> "The term 'air pollutant' means any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct material) substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term "air pollutant" is used."

Clean Air Act § 302. Note that under this definition, oxygen could easily be regarded as a precursor of carbon dioxide.

6. *See* Brad Johnson, *Obama Administration Adds Todd Stern, Lisa Heinzerling to Key Climate Positions*, THE HILL, Jan. 26, 2009, *available at* http://www.hillheat.com/articles/2009/01/26/obama-administration-adds-todd-stern-lisa-heinzerling-to-key-climate-positions.

7. *See* EPA, *Endangerment and Cause or Contribute Findings for Greenhouse Gases Under the Clean Air Act*, http://www.epa.gov/climatechange/endangerment.html.

> "On December 7, 2009, the Administrator signed two distinct findings regarding greenhouse gases under section 202(a) of the Clean Air Act:
> Endangerment Finding: The Administrator finds that the current and projected concentrations of the six key well-mixed greenhouse gases--carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6)--in the atmosphere threaten the public health and welfare of current and future generations.
> Cause or Contribute Finding: The Administrator finds that the combined emissions of these well-mixed greenhouse gases from new motor vehicles and new motor vehicle engines contribute to the greenhouse gas pollution which threatens public health and welfare."

See id; *see also* Steven Mufson & David A. Fahrenthold, *EPA is Preparing to Regulate Emissions in Congress's Stead*, WASH. POST, Dec. 8, 2009.

law schools and environmental organizations, have now become insiders, who in their new roles, have chosen to make the findings the Supreme Court allowed them to make in *Massachusetts v. EPA*.

The consequences of making an endangerment finding for a new pollutant are not trivial. That designation triggers a complicated set of obligations for both federal and state governments under the CAA. None of these new initiatives will be implemented without a struggle. Industry opposition to carbon dioxide regulation is fierce, and its lawyers have geared up for a fight to slow down this process under our creaky administrative procedures. In all likelihood, they will stall implementation by highlighting the multiple mismatches between the institutional arrangements set out under the CAA and any intelligent approach for dealing with GHGs—especially carbon dioxide. Make no mistake about it, carbon dioxide occupies a separate niche from the other five recently designated GHGs—all of which have long been recognized as pollutants under traditional statutory definition. For standard pollutants, it makes sense to seek to drive them as close to zero as is feasible. With carbon dioxide, this strategy is profoundly destructive to all living things.

Given this starting point, it follows that *when* carbon dioxide becomes a pollutant necessarily depends upon the quantities of the gas found in the atmosphere. It is equally clear, however, that we cannot take a nonchalant "the more the merrier" position with respect to carbon dioxide, because *excessive* amounts of it could trigger a process with potentially—but not necessarily—negative consequences. For example, a high concentration of carbon dioxide in the atmosphere could trap sunlight from outer space beneath a canopy of greenhouse gasses, raising the temperature of the earth. The oft-recited nightmare scenario is that if temperatures rise to some as-yet-unknown threshold level, oceans would rise, ice caps would melt, malaria would spread, and humanity would face catastrophe. Yet as Bjorn Lomborg always reminds his readers, a fraction of the resources spent on staving off the long-term consequences of carbon dioxide could be put to good uses right now, such as reducing the scourge of malaria in undeveloped countries by cleaning up the water supply.[8] While it is easy to imagine some doomsday scenario, the more crucial question is what threshold concentration of carbon dioxide would trigger such catastrophic events. This question is similar to asking how much the oxygen supply on earth would have to dwindle before it would imperil human life. The battle then is about *how much* carbon dioxide should be allowed, not whether it should be allowed at all.

Currently, all we can say with confidence is that some amount of carbon dioxide is too much, some amount is perfectly safe, and some too little. But just how does any one, either separately or collectively, decide exactly where to

8. *See* Bjorn Lomborg, *Time for a Smarter Approach to Global Warming*, WALL ST. J., Dec. 15, 2009, at A15.

draw the line that separates these three categories? At times it is hard to distinguish what changes should be welcome, and which should be the source of general concern. Naturally, everyone would like to rely on climate scientists and neutral experts for a dispassionate analysis. A few years ago, the educated layperson might have accepted the benign establishment view that the world was closing in on the point of no return as high levels of GHGs threatened life as we know it. But, as of late, more and more experts are departing from this doomsday perspective, and their hesitancy continues to grow in light of the recent revelation that the once-renowned East Anglia Climate Research Unit (CRU) has engaged in a wide range of questionable practices that smell of data manipulation.[9] At the same time, many impassioned defenders of strong immediate action dismiss the escapades at the CRU as an insignificant aberration.[10]

It is troubling that scientific thinking regarding carbon dioxide appears to follow political trends. Advocates of small government seem to have summarily dismissed the possibility that excessive carbon dioxide could pose real dangers. On the other hand, people who are comfortable with large government institutions—including a reenergized EPA—invariably characterize carbon dioxide as a known looming peril. Because the politics on this issue appear to drive the science rather than the other way around, it is helpful to ask if there is some reasonable middle ground between skepticism and alarmism for those who acknowledge the threat of excessive carbon dioxide but do not expect the world to end tomorrow. For such people, the most prudent course of action is one of watchful waiting, during which time it is critical to vigorously gather information about the level at which carbon dioxide poses a significant threat.

How do we get a handle of the size of the peril? First, we can track the historical levels of carbon dioxide in parts per million, which, as of March 2009, stood at 387 parts per million. That number represents the result of a marked and steady increase in carbon dioxide, which has only intensified during the last decade. One recent report shows that the amount of GHGs entering the atmosphere increased from about 6,510 million metric tons in 1996 to about 8,230 million metric tons in 2006, an increase of approximately 26%.[11] Some portion of this increase is driven by industrialization. To some extent,

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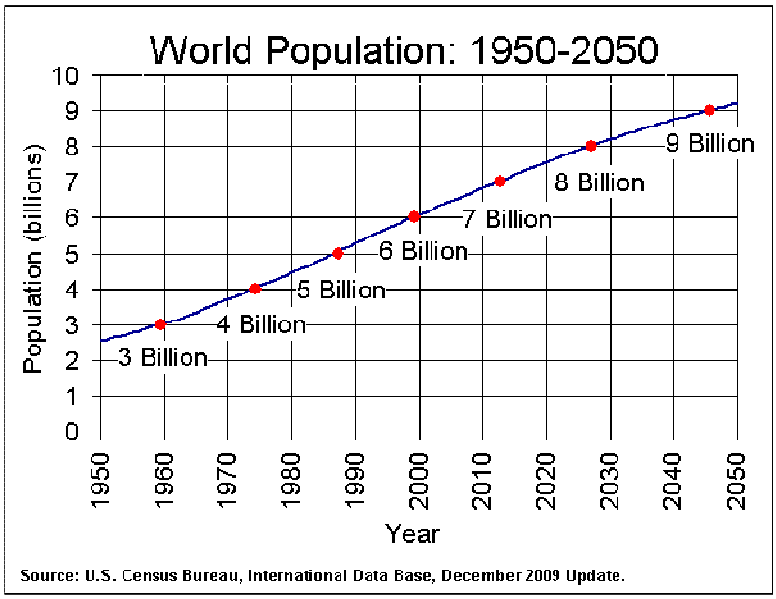
9. *See generally* James Delingpole, *Climategate: The Final Nail in the Coffin of 'Anthropogenic Global Warming'?*, Nov. 20, 2009, http://blogs.telegraph.co.uk/news/jamesdelingpole/100017393/climategate-the-final-nail-in-the-coffin-of-anthropogenic-global-warming/ (one among thousands of references to Climategate).

10. For East Anglia's own defense, *see* CRU update 2, Nov. 24, 2009, *available at* https://www.uea.ac.uk/mac/comm/media/press/2009/nov/CRUupdate (insisting only small amounts of data were missing and published data is consistent with other sources). Clearly this position has it supporters, such as Thomas Friedman. *See* Thomas L. Friedman, *Going Cheney on Climate*, N.Y. TIMES, Dec. 9, 2009, at A43 (expressing disappointment at East Anglia scandal, but defending science showing broad warming trend).

11. *See* Michael Fumento, *Show Me the Warming*, FORBES.COM, Dec. 2, 2009, http://www.forbes.com /2009/12/02/global-warming-geoengineering-obama-opinions-contributors-michael-fumeno.html.

however, it is simply a consequence of the expanding number of people and animals who live on the earth:[12]



Recall that each person exhales about a thousand pounds of carbon dioxide per year, which when multiplied by the 6.8 billion people alive today is 3.085 x 10^9 metric tons, a significant amount, especially when the total amount of atmospheric carbon dioxide is estimated at 3.45 x 10^{12} metric tons. (One metric ton equals 1000 kilograms or 1.1023 short-or American-tons.) The increment from the year 2000 alone is equal to about 363,000,000 metric tons per year. Even more significantly, animals such as cows emit large quantities of methane, CH_4, one molecule of which has the same adverse environmental impact as twenty-one molecules of carbon dioxide.[13] When animals belch, they create major pollution problems for the world in the form of 100 million tons of methane gas per year.[14] These are not tiny numbers.

12. U.S. Census Bureau, International Data Base, *available at* http://www.census.gov/ipc/www/idb/worldpopgraph.php.

13. NOAM MOHR, EARTH SAVE INTERNATIONAL, A NEW GLOBAL WARMING STRATEGY: HOW ENVIRONMENTALISTS ARE OVERLOOKING VEGETARIANISM AS THE MOST EFFECTIVE TOOL AGAINST CLIMATE CHANGE IN OUR LIFETIMES, (2005) *available at* http://www.earthsave.org/news/earthsave_global_warming_report.pdf. "Methane is responsible for nearly as much global warming as all other non-CO_2 greenhouse gases put together. Methane is 21 times more powerful a greenhouse gas than CO_2. While atmospheric concentrations of CO_2 have risen by about 31% since pre-industrial times, methane concentrations have more than doubled." *Id.*

14. *Id.* at 2 (noting animal agriculture number one source of methane).

The situation is driven in large part by the huge populations of China and India, each with well over one billion people and emerging economies, which will continue to generate more GHGs per person as they continue their rapid economic growth. They account for a combined 2.5 billion of the world's 6.8 billion people. Of these, China has about 1.334 billion people and India has about 1.174 billion people. The United States is a distant third place with about 308,000,000 people. While our emission levels per person are about three-fold greater than China's, China today produces about 1.3 times the amount of carbon dioxide that the United States does—with over four times the population. If China's output per person were to double, it would produce about 2.6 times as much carbon dioxide as the United States does today. Even if the United States were to cease all carbon dioxide emissions, the total of United States and China emissions would be 1.6 times its current size. This calculation differs only slightly if we replace China with India. The basic conclusion here is that the actions taken by China and India have far greater consequences for carbon dioxide levels than other countries.

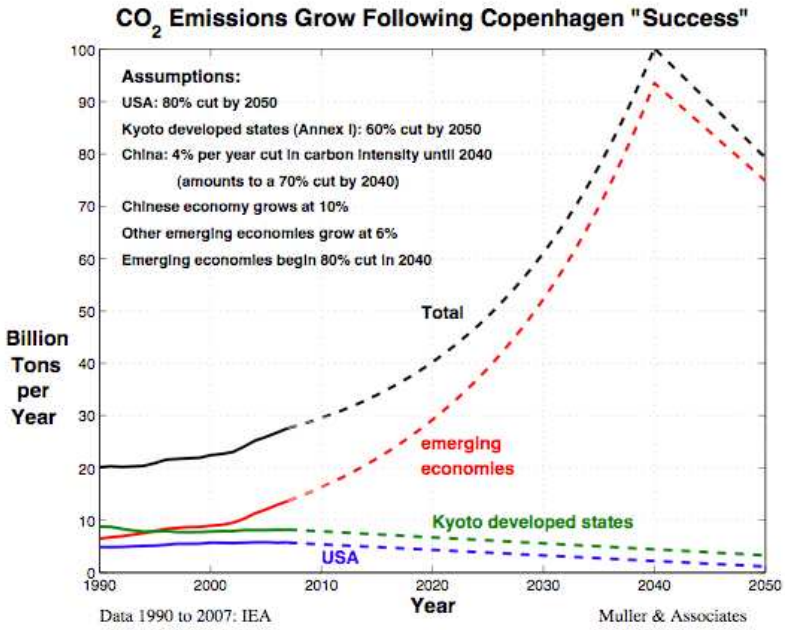
Nonetheless, it does not appear that either China or India is likely to do much belt-tightening, at least in the short run. It is clear in light of the Copenhagen accords that the Chinese will accept less pollution per unit of output for themselves, but such output is rising far more rapidly than China's population.[15] But the increases in the output levels are larger than the deflators from efficiencies, which means that the *aggregate* Chinese pollution will rise, at a stunning rate of 6% per year for each increment in GDP. Against this backdrop, anything that the United States or other smaller developed nations do is a mere rounding error. In 40 years, the United States could cut its pollution levels in half, and have only a modest effect on the overall levels of carbon dioxide. The graphical picture looks like this:[16]

15. *See* Richard Muller, *Naked Copenhagen: Temperature is Increasingly at the Mercy of the Developing World*, WALL ST. J., December 12 2009, at A19.

> China claims it is already cutting carbon dioxide intensity by 4% a year as part of its five-year plan. President Hu Jintao has hinted that at Copenhagen China will offer to continue such reductions. By 2040, that will add up to a 70% reduction in intensity.
>
> Sounds good, but here's the catch: With 10% annual growth in China's economy, a 4% cut in intensity is actually a 6% annual increase in emissions. India and other developing countries have similar carbon dioxide growth. That 6% yearly increase is what is shown in the nearby chart.

Id.

16. Used with the permission of Professor Richard A. Muller, all rights reserved. A version of this graph accompanied Professor Muller's op-ed in *The Wall Street Journal*. *See* Muller *supra* note 15.



Faced with these external realities, it is imperative to examine the nature of the carbon risk not only for the world as it is today, but rather for the world tomorrow if the current trends are left unabated. On this the climate activists insist that we have to take the bull by the horns, or grasp the branch by the nettle. The elaboration of what "may" happen tomorrow is a dominant theme in the EPA's justification of its endangerment finding. The EPA's recent report on this topic goes to great measure to show the dislocations that it expects to follow from a temperature change of "2 to 3 °C above preindustrial levels."[17] Its conclusion therefore is that, as a nation, the United States must be prepared to suffer a measurable harm today in order to avoid catastrophe tomorrow. Unfortunately, it offers neither evidence to indicate when or how this 2 to 3 °C finding is made, nor a distribution of anticipated temperature ranges in the future. These omissions are glaring: the underlying empirical questions cannot receive true or false answers because there is considerable room for disagreement on such complex matters. We need to know what we give up today, and what we hope we hope to gain in exchange tomorrow.

One way to ask that question is to look back at the prevailing attitudes a decade or more ago. It is perhaps obligatory to examine Al Gore's pointed

17. Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, Dec. 15, 2009 74 Fed. Reg. 66,496, 66,534 (to be codified at 40 C.F.R. ch. 1) (predicting predominantly negative consequences for biodiversity and provisioning of ecosystem goods and services resulting from increase).

warning: the world must embrace a "carbon-neutral lifestyle."[18] To do otherwise, he says, will result in a cataclysmic catastrophe. "Humanity is sitting on a ticking time bomb," proclaimed the website for his 2006 film, *An Inconvenient Truth*. "We have just 10 years to avert a major catastrophe that could send our entire planet into a tailspin involving extreme weather, floods, droughts, epidemics and killer heat waves beyond anything we have ever experienced."[19] The relatively calm temperatures of the last decade have done nothing to reassure him that the end is not near. His opponents paint a very different picture, which is noteworthy in itself.

The highest global surface temperature was recorded during the temperature spike of 1998, which was not only a measurable increase over the preceding year, but also far higher than the temperature the following year. While the decade following the spike is not significant in the grand scheme of human history, it is at least long enough to assemble some temperature data. Examining 1999, the year after that spike, we continued to have years that were relatively hot in historical terms, so much so that the last decade was the hottest in recorded history. So there is no way to ignore the issue.

But average temperature is not the only relevant measure of global warming. The rate and direction of change also matters. For example, the trend line over the past ten years shows, in aggregate, a modest cooling of 0.25 degrees centigrade. Temperatures, in a word, are high, but not rising.[20] The 26% increase in carbon dioxide emissions should, if the standard global warming theories are correct, have led to a measurable temperature increase, not a modest decline. Indeed, the flattening of global temperatures makes it difficult to posit any linear relationship between carbon dioxide and global temperatures. It is also difficult to specify any function that points to some systematic lagged temperature increase, for, if that were the case, the 1998 peak should have exerted its influence at some time during the last decade. Further, not all evidence about the future points to global warming. One recent study of the northern hemisphere reported in *Nature* examined a wealth of trends over the North Atlantic, and concluded simply: "Our results suggest that global surface temperature may not increase over the next decade, as natural climate variations in the North Atlantic and tropical Pacific temporarily offset the

18. Open letter from Al Gore in support of People's Ratification of the Kyoto Global Warming Treaty Petition (Sept. 18, 2006), *available at* http://www.climatecrisiscoalition.org/CCC-Endorsement-9-18-06.html (discussing recent post on *An Inconvenient Truth* website).

19. *See* NOAM MOHR, EARTH SAVE INTERNATIONAL, A NEW GLOBAL WARMING STRATEGY: HOW ENVIRONMENTALISTS ARE OVERLOOKING VEGETARIANISM AS THE MOST EFFECTIVE TOOL AGAINST CLIMATE CHANGE IN OUR LIFETIMES, (2005) *available at* http://www.earthsave.org/news/earthsave_global_warming_report.pdf.

20. *See* Posting of Dr. Fred Singer to Reuters blog, http://blogs.reuters.com/great-debate/2009/12/14/climate-skeptic-we-are-winning-the-science-battle/ (Dec. 14, 2009, 10:53EST) (opining increase in carbon dioxide does not have appreciable effect on global temperature).

projected anthropogenic warming."[21] How these effects will net out is now unclear. Likewise, one study of the southern hemisphere reported that the El Nino Southern Isolation has a powerful impact on global temperatures, accounting for about 60% of the overall variance in global temperature—at least in the absence of major volcanic activity, which can exert a powerful downward effect on temperatures.[22]

There are, of course, other studies and other models, and it is entirely possible that other effects could be attributed to the carbon dioxide in the atmosphere. But if this was the case, we should have seen some increase in the level of the oceans, or some meaningful increase in the level of abnormal or hurricane-like activity over these last ten years. There has been little or no change in the climate during these years, and the theoretical relationships are not well understood.[23] While there has been some melting of polar ice caps, it has not been uniform. In any event constant, global temperatures are consistent with regional variations that are highly dependent on local circumstances and seemingly independent of carbon dioxide levels. Al Gore's poster child case of Mount Kilimanjaro appears to fall into this class. The icecap at its peak has shrunk continuously since 1880. Al Gore shows the shrinkage in the ice cap since 1928. But global warming hardly seems to be the explanation. As much of the decrease in size took place between 1880 and 1928 as did afterward. The better explanation seems to be that there is farming at the base of Mount Kilimanjaro, but not at the base of other mountains in the same range, where the ice caps have not shrunk. Local snapshots are thus misleading, given the wealth of other particular explanations that do not depend on global warming.

This complexity may help explain some of the political alignments referred to above. Those who believe in small government set their presumption against state action until it proves beneficial. That presumption leads the cautious to say it is unwise to commit to an approximately $10 trillion enterprise over the next twenty years, in light of only weak evidence that carbon dioxide levels correlate with temperature increases. Those comfortable with large government are likely to set this presumption the other way in marginal cases.

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21. N. S. Keenlyside et al., *Advancing Decadal-scale Climate Prediction in the North Atlantic Sector*, 453 NATURE 84, 84 (May 2008), *available at* http://www.nature.com/nature/journal/v453/n7191/full/nature06921.html.

22. J.D. McLean, C. R. de Freitas, & R. M. Carter, *Influence of the Southern Oscillation on Tropospheric Temperature*, 114 J. GEOPHYS. RES. D14104, doi:10.1029/2008JD011637 (2009), *available at* http://www.agu.org/pubs/crossref/2009/2008JD011637.shtml (finding Southern Oscillation exercises a consistently dominant influence on mean global temperature with exceptions caused by volcanism).

23. *See* THOMAS R. KNUTSON, GLOBAL WARMING AND HURRICANES: AN OVERVIEW OF CURRENT RESEARCH RESULTS, GEOPHYSICAL FLUID DYNAMICS LABORATORY, Jan. 26, 2010, http://www.gfdl.noaa.gov/global-warming-and-hurricanes (analyzing whether global warming affects Atlantic hurricane activity). Knutson's two major conclusions are: "It is premature to conclude that human activity--and particularly greenhouse warming--has already had a discernible impact on Atlantic hurricane activity [and] [i]t is likely that greenhouse warming will cause hurricanes in the coming century to be more intense on average and have higher rainfall rates than present-day hurricanes." *Id.*

There are arguments on both sides of the issue, and the lack of information on the effect of carbon dioxide advises against the kind of commitment demanded by many environmental advocates. It seems best to look for more modest interventions at this stage.[24]

Another pressure point in this analysis is whether, and to what extent, changes in human behavior can impact global warming. The EPA's present intention, for example, is to target only the largest facilities, leaving other sources of pollution to a later day. But this tactic risks the possibility that carbon-producing activities could avoid regulation by moving from large to smaller facilities in the United States, or they could move to offshore locations free of EPA scrutiny. Alternatively, American businesses could be forced to close down, only to see foreign firms spring up in their place, without any cooperation between dying and new firms.

Trying to stop extraterritorial pollution is a nightmare because of the lack of any direct controls apart from international agreements, which themselves could easily flounder over endless disputes about inspection. A myriad of evasions that slow-footed governments could not prevent are likely to defeat taxes on finished products made from carbon dioxide-rich materials. And even if an aggregate decrease in carbon dioxide pollution were to take place, it would be uncertain whether it would increase other sorts of pollution. The forces of evasion at this point seem to be at least one step ahead of the forces of regulation, and such efforts to control the transfer of carbon dioxide through the use of leaky buckets will likely lead to frustration and failure.

These difficulties, moreover, do not appear to depend on the choice of regulatory instruments. Both cap and trade and a carbon tax—both of which are preferable to the CAA's focus on "new" sources of pollution—face daunting problems that are traced to the ubiquity of carbon dioxide, the difficulty of finding appropriate emission levels, and a host of other technical difficulties.[25] There is serious doubt that any concerted effort could, with time, change the outcome by so much as one degree centigrade, at which point a purely random event—another volcanic eruption perhaps, a shift in sunspots—could dwarf it in impact, perhaps by inducing changes two or three times that in magnitude. No plan of gradual emission reductions is nimble enough to respond to such drastically changed circumstances.

There are, then, only three possibilities for the outcome of human efforts to reduce the levels of carbon dioxide in the atmosphere, assuming there is a problem in the first place. The first is that we are safe whether we do it or not. The second is that we are doomed if we do it or not. The third is that our efforts will keep us safe where inaction or lesser action would have doomed us.

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24. *See infra* (setting forth six components of author's modest proposal).

25. *See* Clean Air Act § 111 (standards of performance for new stationary sources); *see also* Clean Air Act § 202 (emission Standards for new motor vehicles or new motor vehicle engines).

Only in the third scenario does human behavior have any effect. Our actions must be at the right levels and correctly timed for such intervention to make a difference. Indeed, if the question is put in terms of United States policy alone, the needle is still more difficult to thread. The smaller quantities are not likely to make the difference, which shrinks the options. No one will be impressed if the best that alterations in carbon dioxide levels can bring about is an inch reduction in ocean levels, and unfortunately scientists do not know exactly what the dose/response ratio is on these complex planet-wide systems. Nor is it easy to learn on the fly. It is not as though some learned body could start running ten-year experiments and then change course if it discovers a mistake. We have a very small rudder, if indeed we have a rudder at all, with which to direct the course of a very large ship in wholly uncharted waters.

There is another way to make the same somber point. As science generally seeks to unpack the different layers of a complex system, you need to set up the key equation with a dependent, or a left-hand side variable whose movement is tied to a range of right-hand side, or explanatory, variables. The coefficients to the right-hand side variable give an estimate of how much of a shift in the right-hand variable will be produced in the left-hand side variable. A coefficient of one means that one variable on the right side of the equation explains everything on the left. That just never happens in complex systems. For these issues, the best prior assumption is that the number of right-hand side variables will be large and the coefficients for each of them will be small. In total, these coefficients can never exceed one, otherwise they would have explained, quite literally, more than "everything." On this assumption, it would be wrong to think of carbon dioxide as some sole right-hand side variable that could carry with it a high coefficient. Moreover, it takes some deep appreciation of the subject to tease out all those right-hand variables, including, of course, the five other conventional GHGs.

It is clearly unacceptable to merely add some error term, as if that would make the incompleteness of the model tolerable. By way of comparison, think of an effort to measure the levels of educational achievement in the American school system. We could say that the left-hand variable is the scores on some standardized test, which serves as a (highly imperfect) proxy for the performance level of students. But even if we ignored the imperfections in this measure no one will say, "Ah-hah! If we change from charter schools to public schools, or vice-versa, that would explain everything." Serious analysts are going to want to control for family size. They are going to want to control for the general level of the economy. The more fertile the theorist, the greater the number of these independent variables, each of which offers a partial explanation with a positive coefficient, which may or may not be significant.

So, when the matter turns to carbon dioxide, we should expect the huge struggles to be focused on the relative size of the coefficients. Proponents of global warming have to posit a single dominant coefficient. Yet a closer look

at the relationship between the temperature and carbon dioxide concentrations leads one to believe on *a priori* grounds that it just has to be a modeling mistake to assume that for this particular dependent variable (temperature), there is only one major independent variable that is going to drive it. More dependent variables—celestial, oceanic, territorial, and human—are needed to flesh out the picture.

The available data in the short term does not support that carbon dioxide-dominant view. It also appears that the long-term fluctuations, over the little ice age and the medieval warming periods, tend not to support the carbon dioxide thesis either.[26] And one of the troublesome concerns with the CRU data is that any smoothing of the differences between the two periods leads to understating the level of natural variability in global temperatures that appear to be unrelated or inversely correlated with carbon dioxide concentrations in the long run. Set against these long-term fluctuations, the apparent gap in the past decade between increased carbon dioxide concentrations and steady temperatures looks more plausible, not less.

It is of course now sensible to start to look elsewhere. I have already mentioned methane as a GHG capable of trapping heat at a far higher rate than carbon dioxide. It alone gives us pause before committing a huge fraction of this nation's resources to controlling carbon dioxide. It is best therefore to take a hard look at the full list of industrial pollutants that are created by a modern society and define what each of them contributes to global warming, and then decide whether we can get a higher rate of return by regulating those substances as opposed to carbon dioxide. The sheer complexity of the analysis makes any serious analyst something of a coward because of the loss of confidence in the simple push/pull version of causation that links every movement in carbon dioxide concentrations to changes in temperature.

It is important to note that all future calculations are subject to catastrophic events—once called Acts of God—which no human being can control or, in

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26. *See* Steven F. Hayward, *Scientists Behaving Badly*, THE WEEKLY STANDARD, Dec. 14, 2009, *available at* http://www.weeklystandard.com/Content/Public/Articles/000/000/017/300ubchn.asp.

> It has long been thought that over the last thousand years the earth experienced two significant natural climate cycles: the "medieval warm period" (MWP) centered around the year 1000 and the "little ice age" (LIA) from about 1500 to 1850 or so. The first report of the IPCC in 1992 displayed a stylized thousand-year temperature record showing that the MWP was warmer than current global temperatures, but this was mostly conjecture. Yet it was a huge problem for the climate campaigners: If the medieval warm period was as warm as today, as some scientists believe, it would mean that today's temperatures are arguably within the range of normal climate variability, and that we could not yet confirm greenhouse gas emissions as the sole cause of recent increases or rely on computer climate models for predictions of future climate apocalypse. There had long been rumors that leading figures in the climate community believed they needed to make the medieval warm period go away, but until the CRU leak there was no evidence besides hearsay that scientists might be cooking the books.

Id.

some cases, adequately predict. Recall Mount St. Helens, which erupted in 1980 and was followed by an extended period of global cooling because the debris that went into the atmosphere shielded the surface of the Earth from the sun in ways that altered growth patterns across the globe. Modeling can only note the existence of these events. It finds it very difficult to give any firm estimate of their occurrence or even their direction, either alone or in the aggregate. The probability of occurrence is clearly small in any one year. But over a generation or two, those probabilities creep up, and they can rudely interfere with fine-spun plans to cut back on pollution by reconfiguring this or that factory or power plant. Such human changes will be small in comparison to the amount of pollutants that will be emitted into the atmosphere by natural events, which are beyond the operations or the control of any organization, and that happens to include our own vaunted EPA. And if scientists cannot reliably model for these sort of random and stochastic events, it becomes extremely difficult to justify committing to a fifty-year regulatory program when we know that there is an 80% chance that one of these events will occur, causing greater atmospheric impact than any domestic regulatory program.

II. THINK GLOBAL: NEITHER CONQUEST NOR COOPERATION

The implications of the above analysis for the question of pollution control are vital. The local systems of control, which may work for sulfur dioxide and nitrous oxides, cannot thrive in the new global setting. National solutions are dubious. International solutions are the order of the day. Just how are these achieved? A quick tour of the law of international relations reveals only two possible approaches to this problem. The first is conquest. The second is international negotiation. One possibility is that the depleted United States military will conquer the rest of the world so as to allow the EPA to impose its will on other nations. It could do so on the ground that nuisance abatement has long been recognized as a reason to allow one neighbor to enter the property of another. On some modest reflection, it seems likely that this approach will run into insuperable moral and logistical obstacles, the chief difficulty being that the United States is having enough trouble in Afghanistan and Iraq as it is. Direct conquest does not look like a viable way to approach environmental externalities. After all, others may try the same tactic against us.

Imagine that there was conclusive evidence that China's actions, if undeterred, would lead to a doomsday scenario. Could we use force then? Perhaps such force would be justified in principle, but it would not work in practice. If there were that kind of drop-dead certainty and everyone understood that no one would survive unless everyone cut back simultaneously, everyone would cut back and the holdout problem would be resolved. Think of this as a case where a ship needs to be bailed at a rate of 100 gallons per minute, and each of 100 people could bail exactly one gallon per minute, no

more. The ship sinks if even one person fails to bail, such that all will bail because each knows that in a real sense his or her conduct is at the margin. Yet introduce the slightest uncertainty, so that only 80% of the people have to bail, and it is far from certain that the holdout problem can be overcome through voluntary transactions. The only option, then, is force, which I suspect will nonetheless fail. In the end the truly dire remedies are best understood to be futile efforts to increase the odds of overcoming the holdout problem. International negotiations tend to take place in a highly libertarian bargaining environment because there are no rights of condemnation or affirmative duties to deal. Climate questions pose problems that libertarianism is least equipped to handle; voluntary bargaining regimes tend to break down where all-inclusive coordination is indispensable to reach a desirable collective solution.

With conquest and domination off the table, the remaining option is international negotiation. An example of such negotiation is the recent inconclusive round of talks at Copenhagen, which represent an invitation to paralysis as all parties joust for partisan advantage in pursuit of their common cause. Before talking about the particulars of the so-called Copenhagen Accord,[27] however, it is useful to be clear on the conceptual framework. Even if one knew the original positions and ultimate objectives of each player at the bargaining table, there are nonetheless too many decision nodes to accurately evaluate. In practice, it would be impossible as a technical matter to project the Byzantine negotiating game between the parties—in game-theoretical terms. If global warming is the problem that alarmists think it is, international meetings will become a doomsday machine because of their utter inability to organize constructive cooperative efforts.

So what are the obstacles that stand in the path of this operation? The first is the level of disparity among estimates as to the severity of the carbon dioxide problem. If we decided to adopt the EPA's current attitude, which places a high priority on rapid reduction of total pollutants, we would need to cut down and, more importantly, persuade others to follow our position. But suppose that the Chinese government disagrees with the EPA's estimates as to the level of environmental damage associated with any particular increase in carbon dioxide concentrations. China believes that these concentrations are less serious than the EPA thinks they are. So the EPA projects that major dislocations will occur once carbon dioxide levels reach 450 parts per million (ppm), while the Chinese do not believe that dislocations will occur until a much higher threshold is reached, for example, at 800 ppm. How will China react to unilateral decisions by the United States to cut back on its carbon dioxide footprint? We would hope that they would act in good faith and imitate our efforts. My prediction, however, is that, as rational choice players, they

27. *See generally* United Nations Framework Convention on Climate Change, Draft decision, http://unfccc.int/resource/docs/2009/cop15/eng/l07.pdf.

will take the opposite tack. Here is how I imagine their internal deliberations:

> A sucker is born every day, and the most recent place of their birth is Washington, D.C. The EPA is now going to impose very serious restrictions on what is to be done with respect to pollution coming out of the United States, and we are going to respond in kind. They are going to reduce the total amount of carbon dioxide, so we may as well increase our output of carbon dioxide and garner all the competitive advantage that we can wring out of their hypercautious blunders. Therefore, let us give thanks, for the United States has done us a huge favor. They have imposed heavy costs upon their own production that thankfully we do not have to incur. What they have providentially done is to make us more comfortable with increasing our total output of carbon dioxide.

So knowing how a rational agent who rejects our carbon dioxide estimates will respond, how should we adjust our stance? This innocent question raises one of the most important issues of international relations, for which there are two schools of thought. The first advocates for what might be called the "politics of virtue." The thinking goes that the United States, as the world's most powerful nation, must lead by example. To show the urgency of the situation, we will act unilaterally by accepting genuine sacrifices in our short-term standard of living. Other nations will come to realize that we are serious in our convictions and ultimately follow suit. It is just this logic that drove the "endangerment" finding at the outset of the Copenhagen world meeting. This approach spurns the lessons of rational choice theory and views cooperation, rather than hostility, as the dominant social norm.

Now, in fact, even the cynics among us adopt this approach in at least some circumstances. Think of the case where you are about to enter a business partnership with a friend. You know the relationship over time will depend on reciprocal trust, and you have the luxury of choosing whom you wish to go into business with. Having chosen well in this regard, you may be wise to follow the advice of your mother or father who says, "You always want to put your best foot forward in this new venture," meaning that it is wise for you to risk some capital first in order to gain the trust of somebody whom you want to court as a reliable trading partner. If he reciprocates, you are in pretty good shape. If not, better to learn early. And many times a good deed is repaid in kind so that both sides gain the benefit of cooperation in an atmosphere of trust. People who can keep to this program rarely regret their choice.

These cases are not uncommon. But as the realist reminds us, they are not universal either. The problem with international negotiations, as the realist reminds us, is that we do not enjoy the luxury of free choice in our business partners. We do not have the ability to shun China or India because we do not think that they will be reliable trading partners. Rather, because they generate

the pollution, they are the ones with whom we must deal. Context matters. In an environment that requires cooperation with rivals, the situation is not so optimistic. The scenario I set out above is likely to become the dominant one. The United States will put its best foot forward, and other nations will take advantage of our naiveté. They will choose to optimize their output of carbon dioxide given their own assessment of the risks of producing an inoffensive pollutant that the United States all too desperately wants to control. In international affairs, 150 other governments could adopt the identical strategy on an individual basis. After all, each of these nations also labor under very powerful internal pressures to act as they perceive to be in the best interests of their own national constituencies. In this international setting, my money is on the non-cooperators, not the cooperators. The key determinants for fruitful reciprocal interactions are not there. In this context, there is no eventual synergy from trade. Rather, the actors can expect a lot of posturing and bloc politics. It is no surprise that the underdeveloped nations briefly walked out of the Copenhagen talks in protest; they want more assistance for their climate reduction activities. Long-term good faith cooperation is not likely. The political situation is likely to get a lot worse before it gets any better.

Faced with that grim scenario, what is the best course of action for the United States? It does not appear that it is to make unilateral concessions. Rather, it is to bargain hard. We prepare to make concessions when others will go along. Thus, we say to everyone generally, "Look, we think that there is a serious problem. We are willing to cut back on our pollutants, but you have to agree at the same time to cut back on your pollutants." This scheme also has its disadvantages. First, negotiations for international treaties are not completed in an hour, a day, a week, or sometimes even a decade. Thus, by the time the United States goes through this waltz—if the doomsday crew are correct—it will be too late. Second, the multinational setting of these negotiations further complicates this strategy. Quite simply, a tit-for-tat strategy can only work in a two-party game. It has no particular relevance in a three-party game, when in the second round, one of the other players decides to cooperate and the other does not. The first player has only one choice, to cooperate or not in the second period. So to reward the one player for good conduct is to reward the second party for bad conduct. To punish the second player is to betray the first. To reward the first is to let the second keep the benefits of his wrong. We have only one response when we need two separate ones. The only way to break away from this single uniform response is through a set of differential side payments, which raises another host of difficulties in light of the many players who have a real interest in the outcome. So the most successful two-party strategy typically breaks down.

Even if someone is able to transcend this problem, there is still the question of how to organize the relative sacrifices necessary to reach some ideal target. And this raises the question of what baseline is appropriate to measure

permissible output levels. The permissible output of carbon dioxide can be measured by gross domestic product, historical use per person or per nation. None of these is inscribed in stone. The United States' output will increase toward the current rates of GHG production by each nation, which puts us in a desirable position given that our per capita production of GHGs is about three times that of China. And we can try to boost that claim by noting that we also have a huge share of the overall global production, much of which we share with other nations. We probably do produce more goods per unit of carbon dioxide than other nations with more primitive technologies. We shall bolster this argument with the claim that long use gives us a kind of prescriptive right to continue on as we have done in the past, just the way people have walked across somebody else's front yard from time immemorial get a prescriptive right to continue. So we keep our current share as the baseline, and accept pro rata deductions from this base.

Dream on. That argument will spur a furious reaction from anyone in China or India. Their response will be laced with incredulity because they will view the United States' position as an attempt to leverage the sins of the American past to gain an American advantage in the future. If the global alarmists are right, other nations will wonder why the nations that committed the greatest amount of environmental damage should be privileged to continue to commit more havoc than everybody else? Other nations can "catch up" with efficient production, and then demand that the United States trend down to the point where its output per person is equal to that of anyone else, so that in the grand scheme of things, India and China get to emit between them about eight times the GHGs that we do, given the eight to one population ratios. They will argue that, only by moving inexorably to those quotas, can the United States atone for its past sins. Further, the traditional logic of the commons does not give priority to early entrants to the commons. They have to back off when others want to use the resource, at least in theory. But the reluctance of established players to give way is known all the way around. So in the end, a likely deal is somewhere between the two extremes, which could mean that India and China get five times the GHGs of the United States.

None of these solutions will be very elegant as people battle over whether the base should be population, GDP, or past use. For each formula, someone can raise a principled objection. By the time the rhetoric cools off, international cooperation will likely have failed because all nations cannot agree on any one benchmark that would permit negotiations to go forward in an orderly fashion. I regard this outcome as the highly likely solution. I have spent enough time with people who work in international affairs to realize that the combination of professional ingenuity and national self-interest will work to frustrate any kind of cross-border cooperative solution. So what will you get? You will get the good folks of New Zealand, as they have already done, trying to figure out how they are going to solve the global warming problem when

their nation has a population of fewer than six million in the middle of the South Pacific. A small start indeed.

These words were first written before the final furious days of the Copenhagen meeting produced an accord, which has been celebrated by some as a real breakthrough in dealing with global warming.[28] But I disagree with this optimistic assessment. First, the talks were premised on an unduly gloomy assessment of the current situation. None of the skeptical voices have been heard in a document that opens with the claim that "climate change is one of the greatest challenges of our time."[29] There is an effort to take steps to keep global temperatures from rising more than two degrees celsius, without any assessment of the recent trend data that is now pointing weakly in the opposite direction. The claim is further made that "deep cuts" are needed "according to science," none of which is mentioned anywhere in the agreement. And of course, there is the usual bromide of the importance of cooperation in international affairs. But the punch line is that the key "[p]arties commit to implement individually or jointly the quantified economy-wide emissions targets for 2020," and, if signatories to Kyoto, to "further strengthen the emissions reductions initiated by the Kyoto Protocol."[30] The first of these commitments only requires nations to do in the international arena what they have agreed to do back home. Yet the agreement is silent as to what happens if a nation chooses to back out in the months or years to come. And the Kyoto Accords impose no obligations on China, India, or the United States. The actual concrete cutbacks are therefore nowhere in evidence. The agreement is best understood for its contrast between its strong pleas for action followed by a policy that largely invites inaction in the short run. There are, of course, good political reasons to announce an agreement that does not bind. It helps set the stage for further negotiations, and it allows nations to give a nod to their global warming enthusiasts back home. But the one dominant impression of Copenhagen is that the real action continues to remain on the domestic front.

III. BACK HOME

If the odds of an international solution through cooperation or coercion are as low as I believe, what course of action is worth considering on the home front? One possibility is enforcement of pollution controls under the current law in the manner envisioned in *Massachusetts v. EPA*. A second possibility is to employ standard strategies of cap and trade and taxation, which will have limited benefit at best. The most hopeful course of action is the creation of new

28. *See* Robert Stavins, *What Hath Copenhagen Wrought? A Preliminary Assessment of the Copenhagen Accord*, AN ECONOMIC VIEW OF THE ENVIRONMENT, Dec. 20, 2009, http://belfercenter.ksg.harvard.edu/analysis/stavins/?p=464.

29. United Nations Framework Convention on Climate Change, Dec. 7-18, 2009, Draft Decision, *available at* http://belfercenter.ksg.harvard.edu/analysis/stavins/?p=464.

30. *Id.*

pollution-reducing technologies that are efficient enough that other nations will want to *buy* them from us in order to increase their own output and to reduce their own pollution, especially that pollution which has adverse local consequences. Therefore, let us consider first why coercion is likely to fail and then why innovation has a better change of success.

A. Enforcement Under the Clean Air Act

The litigation under the CAA has yet to begin, and the outcome is difficult to predict. But although no one quite knows how it will all end, one point is certain: the EPA will meet genuine resistance when it tries, under current statutory and administrative law, to force the square peg into the round hole. *Massachusetts v. EPA* triggers an endangerment that gives the EPA an opportunity to apply the heavy ammunition of the CAA to carbon dioxide. It is an invitation that the EPA should have declined. The structure of the CAA makes it painfully clear that the last "pollutant" Congress had in mind in drafting the CAA in 1970 was carbon dioxide. Its internal structures are not amenable to running any remotely sensible system for controlling carbon dioxide. The key insights here do not come from parsing the word "pollutant" as it appears in a single sentence. It comes from a greater appreciation of the overall structure of the Act. A quick look at the CAA, which is a 1970 confection, seeks, in the grand tradition of American federalism, to fuse the generative power of the national and state government. But compare this to carbon dioxide, where global effect is the central feature. It does not matter where the molecule of carbon dioxide enters the atmosphere. Any atom of carbon dioxide, no matter where it is emitted, will always go into the atmosphere and will mix with all other molecules of carbon dioxide, regardless of source. So it doesn't make a difference whether you emit them in a heavy industrial zone like Los Angeles, or in the Dakota Badlands or in Bangladesh. When it comes to the question of trying to trace its consequences, all atoms are treated equally regardless of their source. Why then use a local strategy for a newly-designated statutory pollutant that has no distinctive local effects?

Moreover, it is an easy, indeed trivial, task to show the powerful local focus of the CAA, for its opening statement plainly reveals its scope and level of ambition:

> The Congress finds—
>
> (1) that the predominant part of the Nation's population is located in its rapidly expanding metropolitan and other urban areas, which generally cross the boundary lines of local jurisdictions and often extend into two or more States;
>
> (2) that the growth in the amount and complexity of air pollution brought about by urbanization, industrial development, and the increasing use of motor vehicles, has resulted in mounting dangers to the public health and welfare,

> including injury to agricultural crops and livestock, damage to and the deterioration of property, and hazards to air and ground transportation;
>
> (3) that air pollution prevention (that is, the reduction or elimination, through any measures, of the amount of pollutants produced or created at the source) and air pollution control at its source is the primary responsibility of States and local governments.[31]

Each and every one of these statements applies to garden-variety pollutants like sulfur dioxide. The reference to "metropolitan areas" makes it clear that the pollution involved deals with high concentrations of people and industrial activities, like the Los Angeles basin. The calculated reference to pollution impacting "two or more states" is just another of those oblique statutory references used to explain why the Congress can assert its regulatory authority over this activity under the then (and now) dominant interpretation of the Commerce Clause. The reference to "complex" pollutants does not describe carbon dioxide, and its acceptance of primary state responsibility is institutionally incoherent for dealing with carbon dioxide. This preamble marks a perfect mismatch between the problem of global warming and the invocation of the CAA. Yet Justice Stevens does nothing to address the poor fit, other than to dismissively quote the Bush EPA which correctly argued that "Congress designed the original Clean Air Act to address *local* air pollutants rather than a substance that 'is fairly consistent in its concentration throughout the *world's* atmosphere," and he then notes further that nothing in the Act's 1990 amendments changed that focus.[32]

Justice Stevens never bothers to ask whether such a simple observation drives a stake through his own substantive position. Rather, he responds in the most general terms possible by writing this: "While the Congresses that drafted §202(a)(1) [allowing the EPA to set standards for "any air pollutant"] might not have appreciated the possibility that burning fossil fuels could lead to global warming, they did understand that without regulatory flexibility, changing circumstances and scientific developments would soon render the Clean Air Act obsolete."[33] In so doing, however, he avoids all serious objections to his position. Flexibility is always a dangerous card to play, for it could as easily lead to the evisceration of the CAA as well as to its overenforcement. And at no point does Justice Stevens discuss the methods contained within the basic statutory framework of the CAA, which do allow the EPA to add new pollutants to the initial list. Nor does he ask whether his desire to prevent the statute from becoming "obsolete" is sufficient to authorize the Court to give EPA carte blanche to rewrite the statute without any input from Congress.

31. 42 U.S.C. § 7401 (2009).
32. *See* Massachusetts v. EPA, 549 U.S. 497, 512 (2007).
33. *See id.* at 532.

Worse, his sole source for this dubious rule of statutory construction is a case that held that the Americans with Disabilities Act applies to prison inmates, which looks like a rather less momentous shift.[34]

The second key design feature in the CAA is that it is faithful, perhaps too faithful, to its conception of cooperative federalism in organizing its overall enforcement. The role of the federal government in air pollution issues is to set national ambient air quality standards (NAAQS) that indicate what concentrations of which pollutants are thought to be acceptable in different regions of the country.[35] The NAAQS thus sets a target that the states have to reach through what is termed a state implementation plan (SIP); this deals chiefly with the allocation of the pollution burden among the new sources that spring up within the region.[36] It then articulates a definition of "hazardous air pollutants," which contains a caveat for "major sources" that trigger additional EPA powers. This caveat applies to any "stationary source or group of stationary sources located within a contiguous area and under common control that emits or has the potential to emit considering controls, in the aggregate, 10 tons per year or more of any hazardous air pollution or 25 tons per year or more of any combination of hazardous air pollutants."[37] Consistent with the federalism system, the SIP can become a federal implementation plan (FIP), if there is some principled objection to the adequacy of the program at the local level.[38] This two-tiered structure makes sense for dealing with the pollution in the Los Angeles basin. However, it is absurd for dealing with global pollution, especially when the aggregate emission levels for carbon dioxide are so low that every small business in America is now considered a major stationary source of pollution.

The same message comes through when we deal with the other key operative categories of the CAA. The statutory framework classifies various regions of the country by the severity of the local pollution within them. Some regions, with the objective of preventing significant deterioration of air quality, may be designated nonattainment areas.[39] These areas contain separate rules for ozone, carbon monoxide, particulate matter, sulfur oxides, nitrogen dioxide and lead, all of which are known to be toxic to human beings. Significantly, carbon dioxide is not on that list. This is not because the substance was unknown in 1970, but because it had no impact on the air quality with which these nonattainment areas were concerned. Next, the CAA contains particular provisions that address pollution that starts in one state only to spill over to the

34. Pa. Dept. of Corr. v. Yesky, 524 U.S. 206, 212 (1998).
35. *See* § 7409.
36. *See* 42 U.S.C. § 7410 (2006).
37. *See* § 7412(a)(1).
38. *See* § 7413(a)(5).
39. *See* § 7407.

next.[40] But the patterns of prevailing winds have nothing to do with the spread of carbon dioxide. None of these provisions make the slightest sense for carbon dioxide because of its uniform distribution and its lack of any short-term effects on particular diseases like emphysema or asthma.

There is yet one other feature of this statute that has misshapen enforcement mechanisms and paradoxically makes it quite likely that we will experience an *increase* in pollution per unit of production in the United States by trying to enforce the CAA. Why this counterproductive result? The explanation turns on one word that was introduced in the 1970 statute that was, to my mind, a fatal mistake even for old-style pollutants: "new." Therefore, when we come back to the term "newest pollutant," it turns out this is a statutory term of art. It points to the difficulty of transitioning from one legal regime to another. In order to get this bill passed back in 1970, some concession had to be made to firms that had developed established emissions patterns legal under the then-existing law, which of course imposed few restraints on pollution emissions. In effect, the polluters thought of themselves then (and indeed now) as holding a set of prescriptive rights based on practices long condoned under the prior law. The high level of pollutants came from facilities that could be neither easily retrofitted nor retired. The modest compromise position was to phase in the CAA by having its constraints apply only to "new" pollution produced not only by stationary sources like power plants and mobile sources like automobiles and their engines, but also by any and all devices that emitted pollution of any sort. The thought was that the retirement of the old pollution sources would join with the introduction of the new sources so that in one product generation the CAA would apply to virtually all potential pollution sources. As we phased out old equipment we could enjoy the benefits of an easy transition to a higher level of environmental protection.

In some ways this program worked. Try as one might, cars get old rather rapidly, and relatively few of the vintage pre-1970 cars are still on the road. But power plants are a different story. One point that legislators and planners forgot about when they hit on this statutory scheme was that the expected life of a particular piece of equipment is not simply a function of its age and current state of repair or disrepair. It is also a function of the cost of replacement relative to the cost of repair. The environmental statutes increase the price of new entrants by requiring that new facilities meet very exacting standards before they are put online. The incredible details of this process are not important for these purposes. What matters is that these requirements make it very expensive to get a new plant approved under the rigorous EPA policies.

The general strictness of the CAA is illustrated by a pair of well-known

40. *See generally* §§ 7501-7509a (2006); §§ 7511-7511f (ozone); §§ 7512-7512a (carbon monoxide); §§ 7513-7513b (particulate matter); §§ 7514-7514a (sulfur oxides, nitrogen dioxide, lead).

Supreme Court decisions: *Union Electric Co. v. EPA*,[41] which addressed the rules that governed the promulgation of SIPs, and *Whitman v. American Trucking Associations, Inc.*,[42] which dealt with the vital power of the EPA administrator to set NAAQS under the CAA. In both of these cases, two justices at opposite sides of the political spectrum took the same position. They held that key provisions of the statute preclude a cost-benefit analysis that might introduce a sensible form of marginalist analysis, which would ask whether the additional precautions were worth their cost.[43] I think that both of these cases offer a correct (if unwelcome) reading of the statutory provisions. The decisive provision in Section 109 states that the relevant ambient air standards "shall be ambient air quality standards the attainment and maintenance of which in the judgment of the Administrator, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health."[44] The parallel provisions on SIPs speak of the plan to implement the NAAQS, "a plan which provides for implementation, maintenance, and enforcement of such primary standard in each air quality control region (or portion thereof) within the state."[45] It is always tempting to read costs into the interstices of statutes that seem to have a rather different agenda, but on this point Justice Scalia seems manifestly correct to insist—in marked contrast to Justice Stevens' flexible reading in *Massachusetts v. EPA*—that this major transformation in statutory design cannot be easily read into the statute that evinces a different program. In *Whitman*, Justice Scalia explained that "Congress, we have held, does not alter the fundamental details of a regulatory scheme in vague terms or ancillary provisions—it does not, one might say, hide elephants in mouseholes."[46] There are so many ways to authorize a cost-benefit approach that it is unwise as a matter of statutory interpretation to infer one in the face of a statute that points in another direction. Justice Scalia takes the sensible approach that Congress can fix this if it wants to be free of all constitutional mistakes.

Moreover, it is instructive to note that, not by chance, Justice Scalia cited in support of this critical proposition *FDA v. Brown & Williamson Tobacco Corp.*,[47] which I regard as one of Justice Sandra Day O'Connor's finest efforts. At issue in that case was the question of whether the FDA could obtain jurisdiction over tobacco on the strength of the broad definition of the term "drug" contained in the Food Drug and Cosmetic Act,[48] which defines the term "drug" to cover "articles (other than food) intended to affect the structure or

41. 427 U.S. 246 (1976).
42. 531 U.S. 457 (2001).
43. *See* the discussion of "best available technology," *infra* at 33.
44. 42 U.S.C. § 7409(b)(1) (2006).
45. § 7410(a)(1).
46. Whitman v. Am. Trucking Ass'ns, 531 U.S. 457, 468 (2001).
47. 529 U.S. 120 (2000).
48. 21 U.S.C. §§ 321 (g)-(h) (2006).

any function of the body."[49] Literally, just about everything fits under that definition, including tobacco, which has all sorts of impacts on the body. It takes only a little ingenuity to assert that anything known to happen is also intended, so the definition is sufficiently broad. That was in essence the approach of Justice Breyer, with whom Justice Stevens joined in dissent, when he wrote that "tobacco products (including cigarettes) fall within the scope of this statutory definition, read literally,"[50] and further that "the statute's basic purpose—the protection of public health—supports the inclusion of cigarettes within its scope."[51]

The problem quite simply is that the statutory framework makes no sense in this expanded context. What kinds of clinical trials does one run to determine the disease for which cigarettes afford a safe and effective treatment? Justice O'Connor took that larger framework seriously, and constantly used the term "context" to drive home her basic point. Justice Stevens, who is never at a loss to distinguish precedents from which he dissented, eagerly embraced this non-contextual ploy in *Massachusetts v. EPA,* which both Justices O'Connor and Scalia had avoided. Stevens offered two grounds for distinction, both unavailing. He first argued that the EPA would only *regulate* (his emphasis) emissions, not ban them.[52] Second, he stated that the "EPA has not identified any congressional action that conflicts in any way with the regulation of greenhouse gases from new motor vehicles."[53] At no point does he explain how the CAA apparatus makes sense with carbon dioxide.

The same measure of unwise strictness is also evident in other key features of the CAA. Thus, in general, any new source review has to follow the "best available technology," under standards that are less than crystal clear.[54]

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49. *Id.*

50. FDA v. Brown & Williamson, 529 U.S. 120, 162 (2000).

51. *Id.*

52. Massachusetts v. EPA, 549 U.S. 497, 531 (2007). Justice Stevens explained that "First, we thought it unlikely that Congress meant to ban tobacco products, which the FDCA would have required had such products been classified as 'drugs' or 'devices.'" *Id.* The Stevens "we" of course was the majority's "they."

53. *Id.* at 531. Justice Stevens argued that, "Second, . . . we pointed to an unbroken series of congressional enactments that made sense only if adopted against the backdrop of the FDA's consistent and repeated statements that it lacked authority under the FDCA to regulate tobacco. We can point to no such enactments here: EPA has not identified any congressional action that conflicts in any way with the regulation of greenhouse gases from new motor vehicles." *Id.* (quoting FDA v. Brown & Williamson, 529 U.S. 120, 144 (2000). At no point does he address the misfit between the basic structure of the CAA and carbon dioxide.

54. *See* 42 U.S.C. § 7475(a)(1)-(8) (2000) (regulating major emitting facilities on which construction is commenced). Section 7475(a)(4) provides that:

> No major emitting facility on which construction is commenced after August 7, 1977 may be constructed in any area to which this part applies unless—the proposed facility is subject to the best available control technology for each pollutant subject to regulation under this chapter emitted from, or which results from, such facility."

42 U.S.C. § 7475(a)(4). Section 7412 also states that:

Looking at this statutory language, it is clear that even if one grasps the semantic meaning of the particular terms, it is hard to make those understandings operational in the context of dozens of institutional choices about technologies that have some real promise but are never quite established at the time that key design decisions have to be made. It is instructive to string these requirements together, and then answer this recurrent question in dealing with "best available technology." For example, suppose one technology costs $1 million to implement in order to eliminate 95% of the pollution from a new plant. Suppose a second technology costs $1 billion to eliminate 99% of the pollution. Which is best available technology and why? Do we prefer 95% palliation for $1 million, or is that extra 4% worth $999 million more? My inner sense tells me that the most important virtue in setting pollution standards is knowing when to quit. But that kind of marginalist analysis, which is consistent with both strict liability and negligence in tort law, is not embedded clearly in the EPA, even before carbon dioxide.

The textual strains of both *Whitman* and *Union Electric*[55] raise their own difficulties. It is one thing to conclude that at every key juncture the text and structure of the CAA, taken together, rule out a generalized cost-benefit analysis. It is quite another to decide what to do once that tool is ruled out. One common statement is that the EPA should engage in a form of "feasibility analysis," under which the EPA may regulate until a large portion of the industry literally fails financially.[56] Under one formulation of this test, in connection with parallel provisions under the Occupational Safety and Health Act (OSHA),[57] where it has been said, "as for economic feasibility, OSHA must construct a reasonable estimate of compliance costs and demonstrate a reasonable likelihood that these costs will not threaten the existence or competitive structure of industry, even if it does portend disaster for some marginal firms."[58] But this quest to split the uprights, either under OSHA or EPA, is much more difficult than it appears. For starters, the ideal approach

> "Emissions standards promulgated under this subsection and applicable to new or existing sources of hazardous air pollutants shall require the maximum degree of reduction in emissions of the hazardous air pollutants subject to this section (including a prohibition on such emissions) that the Administrator . . . determines is achievable for new or existing sources."

42 U.S.C. § 7412(d)(2).

55. *See generally* Whitman v. Am. Trucking Ass'ns, 531 U.S. 457 (2001); Union Elec. Co. v. EPA, 427 U.S. 246 (1976).

56. *See* Jonathan Masur & Eric A. Posner, *Against Feasibility Analysis*, 77 U. CHI. L. REV. (forthcoming 2010) (critiquing this policy exhaustively), *available at* http://ssrn.com/abstract=1452984; *see also* U.S. Census Bureau, *supra* note 12.

57. 29 U.S.C. § 655(b)(5) (requiring Secretary to regulate "to the extent feasible" to prevent health dangers to individual workers). Once again, safety is treated as though it is an on/off switch rather than a matter of degree.

58. United Steelworkers of Am., AFL-CIO-CLC v. Marshall, 647 F.2d 1189, 1272 (D.C. Cir. 1980) (setting forth standard of review for feasibility).

should not depend on the capital structure of the regulated firm. Thus, a firm that knows that it will be forced to go to the last degree will prudently take on as much debt as it can in the hope that high leverage will bring it more quickly to the point of no return. Yet this formula does not explain how leverage should be taken into account, or whether a firm should be treated as marginal because of its leveraged capital. Clearly there should be some way to make these adjustments, but if there is, no one has quite found it. So even if we take some common industry average, it can still work out that all well-endowed firms have to spend the billion dollars for the marginal improvement. Yet the futility of that approach should be apparent once it is recalled that under EPA and OSHA, the regulated firm has to deal with multiple hazards simultaneously, when it is not feasible to spend sufficient amounts on the second risk if the first one has absorbed the firm's equity cushion.

One way of stating the huge design flaw here is that it makes the supposed "best" the enemy of the good. "Next-best available technology" could, ironically, offer a superior solution, as it were. But remember that when all is said and done, all this is counterproductive because it slows down the rate of substitution away from existing inefficient assets, and puts enormous strain on what counts as a sufficient modification to trigger the full-scale review.[59] The irony here is that advances in technology will tend to control pollution, for even if the firm does not take into account all social costs, it understands that pollution means a loss of efficient utilization of its fuel inputs. Therefore, take it as a given that wholly independent of any kind of environmental regulation, newer plants are always going to run more efficiently than older ones. A good machine can turn 95% of its inputs into useful outputs, and that means only 5% pollution, so that you would get that kind of protection. But unfortunately, it is doubtful that the reformist zeal of 1970 was conducive to any serious discussion about the incentive effects of the then novel CAA. Nor does it seem that these issues are high on the agenda of modern environmental reform either. In making these criticisms of the ill-advised current institutional structure, no one can insist that the CAA has been a total failure. The overall environmental position on pollution is surely better today than it has been, especially in places like the Los Angeles basin where the air quality is markedly better than before. But again, the issue is the price at which improvement is gained, which brings us back to the question of institutional design, both for traditional pollution and especially for carbon dioxide.

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59. *See* 42 U.S.C. § 7411(a)(2) (2006) (providing statutory definition of "new source"). "The term 'new source' means any stationary source, the construction or modification of which is commenced after the publication of regulations (or, if earlier, proposed regulations) prescribing a standard of performance under this section which will be applicable to such source)." *Id.*; *see also* 40 C.F.R. § 52.21(b)(2)(i) (2009) (statutory application of "modification" as meaning any change resulting in emissions increase); Wis. Elec. Power Co. v. Reilly, 893 F.2d 901 (7th Cir. 1990) (exemplifying far-reaching application of what constitutes "modification").

B. Taxation and Cap and Trade

The question now arises whether it is possible to move to some newer system that avoids the three relevant dimensions of pitfalls of the current law: first, excessive reliance on local controls of pollution; second, undue emphasis on new products; and third, fetish over best available technology and feasibility analysis. There are two candidates for this role, cap and trade on the one hand and pollution taxation on the other. The modern debates often concentrate on the differences between them. It is, however, more important to note the similarities, both on the positive and the negative side of the ledger.

The first point here is a matter of general theory, with a discrete application here. In principle, it should always be possible to design a first-best tax that operates exactly like a first-best regulation.[60] Put otherwise, the perfect tax and the perfect regulation system will have the same level of overall pollution, and the same production and outcomes by all firms within the system. All superficial differences will disappear. To take the most conspicuous difference, a tax does not set any output restriction, while a quantitative restriction does. But the correct tax will induce the output that is allowed by the perfect quantitative restriction. The ideal quantitative restriction will get those firms with high pollution costs to sell and those with lower pollution costs to buy. The right tax will force the high-cost group out of business and allow the low-cost group to remain in business. Neither the tax nor the regulation will, moreover, distinguish between the old pollution and the new, so that the orderly substitution will take place without the need to stipulate to technologies that are needed to get the job done. No longer will any firm have the incentive to act as if a sensible technology is not feasible. No longer will the government or interveners be able to insist that one technology is better than the other. Set a sensible level of outputs subject to the tax or regulation and no one will, in the example just given, decide to force expenditures of $999,000,000 to get the last 4% of pollution.

The point here is not just theoretical. Right now, cap and trade systems are in place for pollutants like sulfur dioxide and the results have been encouraging.[61] There is little doubt that for traditional localized pollution, either or both of these systems would be preferable to the system in place. But carbon dioxide is much harder to work through either of these systems because

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60. *See* George J. Stigler, *The Theory of Economic Regulation*, 2 BELL J. OF ECON. & MGT. SCI. 3 (1971) (discussing various tax and regulatory strategies to restrain rivals).

61. *See* 42 U.S.C. § 7410(a)(2) (authorizing state SIPs to include "economic incentives such as fees, marketable permits, and auctions of emission rights"); *see also* THE CAP AND TRADE SUCCESS STORY, ENVIRONMENTAL DEFENSE FUND, http://www.edf.org/page.cfm?tagID=1085 (noting trading prices are lower than expected, which implies lower demand for permits and thus lower level of emission). The Environmental Defense Fund praised the cap and trade system, noting that the program has had high compliance rates and the banking of permits has lowered sulfur dioxide concentrations. *See* THE CAP AND TRADE SUCCESS STORY, *supra*. *See generally* RICHARD L. REVESZ, ENVIRONMENTAL LAW AND POLICY 177 (2008).

of some common-mode problems. The tax system has to postulate some tax rate for each level of emissions: it has to be comprehensive enough to get enough sources to avoid the displacement problems referred to above, and someone has to decide whether existing polluters get credits against the tax, and if so, at what tax level. No one knows what that tax level should be on either the local or global level because no one can do the reverse engineering to hit the desired target given the parlous state of the science, not to mention the limitations on econometric techniques. Next, the credit allocations to existing users depends on the contested question of whether a given firm had properly invested in pollution-risk technologies under government pressure. And last, there is the question of what to do with the revenues, which could be raised either by taxes or by the sale of permits: do we reduce other revenue sources or increase government activities? The problems, however, are a mirror image of one another. If we cannot set the tax in a carbon tax system, then for the same reasons we cannot set the cap in a cap and trade system. The same problems remain: too much leakage to small emitters, including farm animals, no real knowledge of the magnitude of the harm that one is trying to avert, and no confidence that we can decide who gets the trading rights for free and who has to purchase them at some auction.

One does not have to push very hard to realize that both approaches stumble over the same obstacles. There may well be second-order political economy questions that could tip the balance as between both of these alternatives, such as: which system will place informed experts in charge, or which system is subject to revision. One nice feature about cap and trade, for example, is that it allows private parties direct access to the system if they want to reduce pollution. All they need do is enter the market, buy the permits and retire them from use, which has been done with sulfur dioxide. There is of course some limit on the willingness of some individuals to bear the sins of the world. But just as conservation and preservation easements have worked in other contexts, they also can, and do, work here. There is less of an opportunity for this form of intervention on the tax side—for who gets paid to lower output? But we do not want to get caught in these second-order issues. The basic point is that the knowledge requirements for either a tax or cap and trade are not met in the carbon dioxide context.

The question now is whether any climate control legislation will pass Congress. Temperatures have been cooling, but tempers have been rising. At present, my view is that Congress will not pass any such legislation. The high costs will not sit well in bad economic times. It is just too much of a shot in the dark to go full steam ahead on the strength of imperfect science in the face of a persistent economic downturn. And even if it is passed, the prediction is that all the administrative targets for enforcement will be relaxed either by administrative decree or by special Congressional action—which happened for example with the implementation of the SIP in *Sierra Club v. EPA,* which

contained ambitious clean-up programs for the Washington, D.C. metropolitan area[62]—and with the implementation of the emission standards for new motor vehicles.[63] The fragile political consensus on global warming makes it highly unlikely that the decision can be made in a consistent coherent fashion once and for all. Domestically, the gulf between the two political parties is too great, and there is no question that the energy-intensive industries tend to be in Republican states, which gives rise to a differential impact that will add another element of long-term instability.

IV. MODEST PROPOSALS

The information that I have so far reviewed leaves it unclear whether the glass is half empty or half full. On the one hand, I think that there is good reason to believe that the threat from global warming is overstated, which would be welcome news if true. On the other hand, if it is not overstated, I have sought to explain what I believe to be the major shortfalls of all current and proposed solutions. So what then should be done about this problem, given that no one is sure about what the future will bring?

My preferred program has six key components. First, fix the CAA, which suffers from the design flaws that I outlined above. On this regard, either cap and trade or a system of pollution taxes works far better than any effort to make collective judgments about the "best available" technology as a precondition for launching new facilities or vehicles. In one sense, this is a reprise of the old tort debates between negligence and strict liability, where the great advantage of the latter is that it holds people (in cases of loss to strangers) responsible for what they have done, not for the efforts that they may, or may not, have made to avoid the harms in question.[64] The "best available" technology is the worst possible approach because it hangs regulators up on small differences between alternative technologies when it makes far more sense to let the parties pick their own technology so long as we are able to monitor their output and force them to live with the costs (and benefits) of their own decisions. Getting a better handle on the environmental consequences of different types of pollution can only improve matters.

Second, go after the low-hanging fruit, by stopping those forms of pollution that are easiest to control. Methane is one obvious place to secure substantial

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62. Sierra Club v. EPA, 294 F.3d 155, 158 (D.C. Cir. 2002) (overturning EPA's grant of time extension).

63. *See* Int'l Harvester Co. v. Ruckelshaus, 478 F.2d 615, 650 (D.C. Cir. 1973) (allowing one-year suspension of 1975 emission standards over EPA objections).

64. I have argued this point for longer than I care to remember. *See* Richard A. Epstein, *A Theory of Strict Liability*, 2 J. LEGAL STUD. 151, 154-57 (1973) (attacking Hand formula propounded in Carroll Towing v United States, 159 F.2d 169 (2d Cir. 1947)); *see also* Richard A. Epstein, *Activity Levels Under the Hand Formula: A Comment on Gilo and Guttel*, 108 MICH. L. REV. FIRST IMPRESSION 37, 37-39 (2009) (my most recent jabs criticizing modern interpretation of Hand formula). *But see* Richard A. Posner, *A Theory of Negligence*, 1 J. LEGAL STUD. 29, 32 (1972) (endorsing Hand formula).

benefits. In the short run, the gas contributes more to global warming than carbon dioxide. In addition, it has other dangerous properties, which are worth curbing. Nor is it too difficult to secure major advantages without disrupting the overall economy. For example, it is not too difficult to take infrared pictures of various facilities to see the extent to which they are emitting methane gas, which can be trapped and recirculated for other uses. In a similar vein, taxing the wrong kind of feed for cows and other animals could reduce a substantial amount of emissions from that source. The hope here is to buy some more time so that the technology will evolve in ways that make us less dependent on fossil fuels. And these solutions do not have to address global warming as such; they can work at a far lower level. Here is one tiny example of what I mean. When I took the cab from Cambridge to Boston to give this lecture, I was told that the Cambridge cabs could not pick up in Boston, and vice versa. These restrictions are a silly form of economic protectionism that should be attacked in their own right. But they have the collateral consequence of using fuel for nothing, causing pollution that is easily avoided. There must be thousands of such small traps, each of which could be eliminated in ways that improve the bottom line without any new taxes or regulation. With a little bit of imagination, we could make similar changes with trains and airlines, and eventually rationalize the whole transportation sector in a way that gives parties incentives to use fuel efficiently. Just charging more for people who do not use the E-Z pass would induce a major change in behavior that would reduce the deadly cocktails of automobile emissions. Getting accurate pricing for passes into the national park system would reduce the queuing at the entranceways and the pollution that it produces.

Third, remove subsidies that lead to the destruction of forests. Whether one lives in Iowa or Massachusetts, there is simply no justification for doling out substantial ethanol subsidies to induce people to substitute it for gasoline. Those choices should be based on the relative efficiency of the two products, where in both cases it is critical to control the externalities by taxation. The subsidies lead to the distortion of agricultural markets and induce boom and bust cycles in the industry. Any sensible set of reforms has to force the farm states to back off from these dangerous programs, and the sooner they do, the better. The ethanol situation is driven by the usual suspects: government mandates on fuel and heavy subsidies for domestic production that average around fifty-one cents per gallon, topping out at about $5 billion per year.[65]

Fourth, simplify the regulation on nuclear power. That task can only be done by rebuilding, from the ground up, a regulatory structure that has prevented the construction of a single new plant since 1977. The specter of Three Mile Island dominates policy while other nations have pushed hard and

65. *See* Jeff St. John, *Corn Ethanol's Subsidy Glut*, GREENTECHMEDIA, Jan. 9, 2009, http://www.greentechmedia.com/articles/read/corn-ethanols-subsidy-glut-5489/.

successfully in this direction. Under the current process, it takes parties decades to get a license. The entire waste disposal process is mired in red tape and political intrigue. Someone has to change it, and perhaps climate change could be the impetus for some urgency on this score. Note that in making this plea, I am not urging public subsidies for nuclear power, just a removal of regulatory barriers that have become a bed of thorns.

Fifth, shun industrial policy, especially one that uses the government to pick preferred pollution control technology. By the same token, we should not indulge in any form of public subsidy for other clean forms of energy production, which may or may not pan out. What is needed is not government experts picking winners (who fail), but a sensible scheme of taxation that allows any entrepreneur a decent return on investment, and a system of intellectual property law that is geared toward the imperatives of innovation. This once again depends on a set of strong patent rights that can be utilized in combination through the operation of voluntary markets. One hidden advantage of this approach is to generate technology that other nations will be prepared to *purchase* because it will be in their own local interest to do so.

Sixth, ensure that investments in global warming are accurately timed. There is, in all discussions of temporal issues, the question of whether it is better to accumulate your wealth today and spend it tomorrow in order to achieve some long-term end. For example, people who worry about surgery may postpone for a year or two to wait for some newer technique that is less invasive than those that are now available. There is no uniform *a priori* answer to the question of whether waiting is worthwhile. If the person's condition is likely to deteriorate rapidly in the interim, strategic waiting could lead to poor outcomes. If there are some effective ways to slow the rate of decline, the opposite conclusion may be appropriate.

In education, for example, there is good reason to think that early childhood interventions do more for the child than the investment of a somewhat larger amount of money a year or two later.[66] But with global warming the calculations could easily run in the opposite direction. We are not even sure of the direction of temperature changes, let alone their magnitude, so we do not have the wealth of empirical evidence that is available in the education context. At this point, the cautious method looks far more attractive. Getting this message across is hard, to be sure, because of the endless technical disputes. But at least for the moment, the EPA's endangerment finding seems to be both an environmental and institutional mistake. Watchful waiting looks to be the far better policy.

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66. *See* James J. Heckman, *Skill Formation and the Economics of Investing in Disadvantaged Children*, 312 SCIENCE 1900, 1901 (2006), *available at* http://jenni.uchicago.edu/papers/Heckman_Science_v312_2006.pdf.