ARTICLES

CLIMATE CHANGE CONFUSION AND THE SUPREME COURT: THE MISGUIDED REGULATION OF GREENHOUSE GAS EMISSIONS UNDER THE CLEAN AIR ACT

*Jason Scott Johnston**

INTRODUCTION

In the spring of 2007, the U.S. Supreme Court ruled in *Massachusetts v. EPA*[1] that the U.S. Environmental Protection Agency (EPA) must promulgate automobile tailpipe carbon dioxide (CO_2) emission standards under section 202 of the Clean Air Act (CAA).[2] American environmentalists hailed the Supreme Court's decision as an important victory in the battle to curb global warming. It is not. The majority opinion in *Massachusetts v. EPA* resonates with the alarmist rhetoric that has come to dominate the climate change policy debate and its reasoning reflects fundamental misunderstandings regarding the likely impact of global warming on the health and welfare of the people of the United States that climate change alarmism has created. An

* Robert G. Fuller, Jr. Professor and Director, Program on Law, Environment and Economy, University of Pennsylvania Law School. For very helpful comments on earlier versions of this Article, I am grateful to Cary Coglianese, Timo Goeschl, Robert Hahn, Ute Mager, Nele Matz-Lück, Raimund Schwarze, participants at workshops at the University of Heidelberg and Georgetown University Law Center, and attendees of a public lecture at the American Academy in Berlin, where a portion of this Article was presented.

1 127 S. Ct. 1438 (2007).

2 42 U.S.C. § 7521 (2000).

extensive and very well established body of systematic empirical economic evidence shows that in the short-to-medium run, a warmer climate will be predominantly beneficial, rather than harmful, to the United States. In the longer run, investments to reduce greenhouse gas (GHG) emissions may pay off in a lessened probability of harmful climate change, but whether they do so will depend almost entirely upon the actions taken by other countries, in particular by China.

In apparent ignorance of these basic facts about climate change, and in an almost hysterical frenzy to do something about the supposedly imminent demise of our blue planet, the Supreme Court majority in *Massachusetts v. EPA* interpreted the CAA—intended by Congress to reduce largely localized air pollution and thereby provide the local public good of improved health—as requiring EPA to impose GHG emission limits. Not only will such limits likely be ineffective, but by requiring EPA to regulate greenhouse emissions, the Court has effectively forced a change in the status quo that makes economically sensible and environmentally sound federal climate change legislation much less likely. Moreover, unlike the air pollution that Congress intended to regulate under the CAA, even if the United States were to immediately implement effective GHG reduction strategies, those efforts might have little or no impact in reducing harm from global warming. It is the atmospheric stock of CO_2 and other GHGs that is contributing to global warming, and the flow of GHG emissions from the United States is only a fraction, and a likely declining one at that, of the total global flow. It is China, and not the United States, that is the world's largest GHG emitter, and it is China that now accounts for the majority of the growth in global GHG emissions.[3] Paradoxically, it is possible that the more effective present day U.S. GHG emission limits are, the lower the future incentive for rapidly industrializing, dominant CO_2 emitters such as China to themselves curb such emissions.

This Article begins in Part I by briefly summarizing the Court's opinion in *Massachusetts v. EPA*. In Part II, I then set out a general framework for analyzing the opinion, and apply that framework in three stages. First I recall the goals, objectives, and structure of the CAA and argue that the likely pattern of costs and benefits from climate change in the United States bears no resemblance to the pollution problems that Congress intended to deal with in the CAA, so that that law cannot reasonably be interpreted to cover greenhouse gas emissions. My argument relies heavily upon a very large empirical economic literature that shows how in the short-to-medium term—up to the year 2100—climate change will likely generate net benefits for

3 *See* sources cited *infra* note 236.

the United States, not net costs. One cannot fault the Supreme Court opinions in *Massachusetts v. EPA* for failing to even acknowledge the existence of this evidence; the government apparently did not produce it, and none of the reports of the ostensibly authoritative Intergovernmental Panel on Climate Change (IPCC) thoroughly discuss this or any other economic work on climate change. But the economic evidence is extensive and extremely important: it shows that temperature increases in the two to three degree centigrade range are likely to provide many regions of the United States with large benefits in the form of the amenity value of a warmer climate, increased agricultural productivity, reduced deaths and disease due to cold weather, and increased value from warm weather recreational pursuits.

To be sure, this same body of empirical work shows that some regions in the United States may be net losers from a warmer climate (even prior to 2100). But the costs of reducing GHG emissions fall disproportionately not on those states and regions that have the most to lose from a warmer climate and therefore potentially the most to gain from GHG emission reductions, but rather on states and regions that would actually likely be benefited by a warmer climate. The CAA imposed federal air pollution reduction requirements on some places that did not have a serious air pollution problem at the time and its costs were not uniformly felt (auto industry states likely bearing more costs). These interstate variations in the distribution of costs and benefits were well known by federal legislators, and legislative bargaining over their allocation is in large part responsible for the complexity of the CAA. But overall, the CAA mandated costly nationwide air pollution reduction that generated nationwide health and welfare benefits. To interpret that statute as covering GHG emissions, as the Supreme Court did in *Massachusetts v. EPA*, is to presume that legislators who voted to impose costs on some of their constituents so that all of their constituents would get present and future benefits from cleaner air would also have voted to impose even larger costs on all their constituents so that people in other states or districts could perhaps someday get benefits from a stabilized climate. To take this view, which comprises the Court's core holding in *Massachusetts v. EPA*, is not to interpret the CAA, but to rewrite it.

As I explain in Part IV, one cannot instrumentally justify this core holding by pointing to the desirable incentive effects that it will have in spurring Congress to take action on climate change. By effectively forcing EPA to regulate GHG emissions under a statute that was never intended to cover the very different problem of climate change, the Court has changed the policy status quo in a way that makes socially desirable climate change legislation at the federal level much less

likely. The Court's decision provides the illusion of benefits to advocates of climate change action, and so lessens the marginal legislative benefit from expending resources to introduce and enact economically and scientifically sound climate change legislation. While the Court's decision may ultimately impose costs, those costs will result only if and when regulations are written, implemented, and enforced. These subsequent stages are traditional venues for lobbying and litigation, and with so many opportunities to reduce the ultimate impact and cost of the Court's decision, Congressional representatives from states and regions that stand to lose from GHG emission regulation have no need to take additional costly legislative action.

This same analysis yields another positive prediction: the *threat* of regulation of greenhouse gases under the CAA might actually speed congressional action to *pass* global warming legislation. If regulation of greenhouse gases under the CAA would indeed decrease the marginal political benefit of global warming legislation to federal legislators who are in favor of such legislation, then threatened regulation would put them in a position where by failing to act before a regulation is promulgated, they risk losing political benefits. Legislators whose constituents are net cost-bearers from greenhouse gas regulation and/or global warming legislation will oppose the legislation just as they would seek to blunt effect of regulation.

It might be argued that even if the Court's decision in *Massachusetts v. EPA* fails to spur a desirable federal legislative response, it may well spur action on climate change by other nations. As my central thesis maintains, however, climate change is a remarkably different problem than traditional air pollution. Whereas the U.S. Congress could take effective unilateral action in the CAA to curb U.S. air pollution, neither it nor EPA can take effective unilateral action to reduce harms to (some parts) of the United States from global warming. As I explain in Part IV, given the global nature of the greenhouse gas emission problem, unilateral emission limits in the United States are likely to be worse than ineffective, in that they will likely have the perverse effect of lessening the incentive for latecomers to climate change regulation (such as China) to themselves take costly action to reduce such emissions.

I conclude in Part V by stressing the important limits to the argument that I am making in this Article. My argument that the Court badly erred in interpreting the CAA to encompass GHG emissions does not imply that the United States should simply ignore global warming and make no effort to curb its GHG emissions. Various strands in the climate change scientific literature show that in the long run, global warming may bring highly uncertain, but nonetheless

potentially very harmful, long-term consequences to the United States. In the short-to-medium run, global warming may cause significant harm in developing countries. A sensible formulation of U.S. climate change policy would involve measures to respond both to the long-term threat to the United States and the short-term threat to developing countries. There are policy instruments appropriate to these goals. Large increases in subsidies for research and development into clean coal and alternative fuels are a sensible way for the United States to respond to the long-term threat to the United States. Redirecting foreign aid to fund climate change adaptation in developing countries is a sensible way to respond to the short-term threat to developing countries. But neither these nor other sound responses to climate change can be pursued within the framework established by the 1970 CAA.

I. The Supreme Court and Climate Change: An Overview of *Massachusetts v. EPA*

The litigation in *Massachusetts v. EPA* began in 1999, when the State of Massachusetts (along with several other state and local governments and environmental groups) filed a rulemaking petition requesting that the federal EPA regulate "'greenhouse gas emissions from new motor vehicles'" under section 202(a) of the federal CAA.[4] After receiving thousands of comments, and requesting a special report from the National Research Council, EPA denied the petition for rulemaking.[5] EPA explained that it either lacked the authority to issue climate change regulations under section 202(a) of the CAA, or if it did have such legal authority, then as a policy matter, it would choose not to exercise that authority. More precisely, on the first point, EPA argued that Congress had considered and decided against regulating greenhouse gases under the CAA, and that greenhouse gases were not "air pollutants" subject to regulation under section 202 of the CAA.[6] On the second point, EPA found that there was too much uncertainty over the causal relationship between global mean

4 *EPA*, 127 S. Ct. at 1449 (quoting Int'l Ctr. for Tech. Assessment, Petition for Rulemaking and Collateral Relief Seeking the Regulation of Greenhouse Gas Emissions from New Motor Vehicles Under § 202 of the Clean Air Act at 1 (Oct. 20, 1999), *available at* www.icta.org/doc/ghgpet2.pdf).

5 *Id.* at 1449–50.

6 *Id.* at 1450–51 (citing Control of Emissions from New Highway Vehicles and Engines, 68 Fed. Reg. 52,922, 52,925–29 (Sept. 8, 2003)). In pertinent part, section 202(a) of the CAA states that "[t]he [EPA] Administrator shall by regulation prescribe . . . standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles . . . which in his judgment cause, or contribute to, air

temperature change and human greenhouse gas emissions, and that regulation of such gases under section 202 of the CAA would in any event conflict with the national policy on climate change adopted through Executive Order, an approach that relied upon incentives for technological innovation and voluntary reductions in greenhouse gas emissions and which emphasized the need for greenhouse gas reductions by both developed and developing countries.[7]

The plaintiffs' appeal of EPA's refusal to regulate to the U.S. Court of Appeals for the D.C. Circuit was denied,[8] but the plaintiffs in *Massachusetts v. EPA* had better luck with the Supreme Court. Over strenuous dissents on all points, a bare five Justice majority held that not only did the plaintiffs have standing to bring their suit, but also that EPA did indeed have the statutory authority to regulate GHG emissions as "air pollutants" under section 202 of the CAA.[9] The majority concluded that EPA could not refuse to exercise this authority on policy grounds—such as the potential conflict with executive branch climate change initiatives—that were inconsistent with the substantive regulatory standard found in section 202—whether or not the pollutant "'cause[s], or contribute[s] to, air pollution which may reasonably be anticipated to endanger public health or welfare.'"[10]

The Court's discussion of its final point—that the policies relied upon by EPA were inconsistent with the statutory standard requiring a finding that endangerment of public health or welfare could "'reasonably be anticipated'"[11]—was very short. According to the majority, the existence of "residual uncertainty" as to "various features of climate change" is irrelevant to the statutory question that the agency must address, which is "whether sufficient information exists to make an endangerment finding."[12] EPA's obligation to make this reasonable endangerment finding in turn reduces to an obligation to form a "scientific judgment" as to whether "greenhouse gas emissions cause or contribute to climate change."[13] Obviously, in the view of the majority, this scientific judgment does not require consultation with

---

pollution which may reasonably be anticipated to endanger public health or welfare." Clean Air Act (CAA) § 202(a), 42 U.S.C. § 7521(a) (2000).

7 *EPA*, 127 S. Ct. at 1451 (citing Control of Emissions, 68 Fed. Reg. at 52,929–31).

8 *Id.* at 1451–52 (citing Massachusetts v. EPA, 415 F.3d 50, 58–59 (D.C. Cir. 2005)).

9 *Id.* at 1458, 1462.

10 *Id.* at 1462 (quoting 42 U.S.C. § 7521(a)(1)).

11 *Id.* (quoting 42 U.S.C. § 7521(a)(1)).

12 *Id.* at 1463.

13 *Id.*

the State Department and has "nothing to do"[14] with whether regulating greenhouse gases under the CAA would impair the President's ability to negotiate with developing nations to reduce their emissions.

The bulk of the majority's opinion is devoted to justifying its holding that the plaintiffs have standing to sue and that EPA has statutory authority to regulate. The Court easily concluded that EPA has the authority to regulate GHGs as air pollutants under CAA section 202. According to the Court, there was no ambiguity at all in the statutory definition of "air pollutant"—as "any air pollution agent or combination of such agents, including any physical, chemical . . . substance or matter which is emitted into or otherwise enters the ambient air"[15]—which clearly encompassed CO_2 and other GHGs.[16] Moreover, for the Court, congressional action and inaction during the 1980s—in failing to amend the CAA to explicitly include emissions limits for GHGs but instead merely encouraging interagency collaboration and research—"tells us nothing about what Congress meant when it amended § 202(a)(1) in 1970 and 1977."[17]

In finding that the constitutional requirements for standing were met, the Court relied on two rather different theories. On the one hand, the majority said that Massachusetts had met the traditional (albeit not very old) three-pronged test requiring (on summary judgment) that the plaintiff produce affidavits and similar evidence (1) of a concrete and particularized injury that is either actual or imminent; (2) that the injury is fairly traceable to the defendant; and (3) that it is likely that a favorable decision will redress that injury.[18] As to the first requirement—that the plaintiff suffer a "concrete and particularized injury"—the Court relied almost entirely on the affidavit opinion of climate scientist Michael MacCracken to the effect that "'qualified scientific experts involved in climate change research'" have reached a "'strong consensus'"[19] that global warming had caused an increase of global sea levels of "between 10 and 20 centimeters over the 20th century," and that these "rising seas have already begun to swallow Massachusetts' coastal land"[20] and "[i]f sea levels continue to rise as predicted, one Massachusetts official believes that a significant frac-

14 *Id.*

15 42 U.S.C. § 7602(g) (2000).

16 *See EPA*, 127 S. Ct. at 1461.

17 *Id.* at 1460.

18 Summarized, for example, in *Lujan v. Defenders of Wildlife*, 504 U.S. 555, 560–61 (1992).

19 *EPA*, 127 S. Ct. at 1455–56 (quoting declaration of Michael C. MacCracken ¶ 5).

20 *Id.* (citing declaration of Michael C. MacCracken ¶ 5).

tion of coastal property will be 'either permanently lost through inundation or temporarily lost through periodic storm surge and flooding events.'"[21] Having found that such sea level rise constituted a "concrete and particularized injury" to the State of Massachusetts, it was not difficult for the majority to go on to find that the other two prongs of the standing test were met. The MacCracken affidavit also established causation, for according to that affidavit, CO_2 emissions from the United States transportation sector alone would make the United States the third largest emitter of CO_2, so that "[j]udged by any standard, U.S. motor-vehicle emissions make a meaningful contribution to greenhouse gas concentrations and hence, according to petitioners, to global warming."[22] Finally, as to remedy, for the majority of the court, even if developing countries such as China and India increase greenhouse gas emissions "substantially" over the next century, "[a] reduction in domestic emissions would slow the pace of global emissions increases, no matter what happens elsewhere,"[23] so that federal emissions limits would indeed remedy the plaintiff's harm.

The Court also set out an alternative and quite novel ground for Massachusetts' standing: that State's "quasi-sovereign interests" in protecting its territory by invoking its "procedural right to challenge the rejection of its rulemaking petition as arbitrary and capricious."[24] The majority found this theory of quasi-sovereign state standing not in its constitutional jurisprudence, or in any case involving standing to challenge rulemaking by a federal agency, but rather in *Georgia v. Tennessee Copper Co.*,[25] an interstate nuisance dispute involving a lawsuit by the State of Georgia against a private polluter located in the adjacent State of Tennessee.[26] That case involved the federal common law of interstate nuisance, an area that the Court has long ago held was preempted by the new federal environmental statutes.[27] Nonetheless, the

21 *Id.* at 1456 (quoting declaration of Karst R. Hoogeboom ¶ 6).

22 *Id.* at 1457–58.

23 *Id.* at 1458.

24 *Id.* at 1454–55. The source of the "procedural right" mentioned by the Court is 42 U.S.C. § 7607(b)(1) (2000). While it is outside my primary purpose in this Article, it is worth noting that § 7607(b)(1) had not previously been understood as conferring any "procedural right" beyond that already conferred by the Administrative Procedure Act; instead, it simply provides that judicial review of emission standards under the CAA can be had only in the D.C. Circuit.

25 206 U.S. 230 (1907).

26 *Id.* at 236.

27 *See, e.g.*, City of Milwaukee v. Illinois, 451 U.S. 304, 317–19 (1981) (holding that in enacting the 1972 amendments to the Federal Water Pollution Control Act, Congress "strongly suggests that there is no room for courts to attempt to improve on that program with federal common law").

majority in *Massachusetts v. EPA* approvingly quoted language from the old interstate nuisance case that defines a state's "'*quasi*-sovereign'" interest as one "'independent of and behind the titles of its citizens, in all the earth and air within its domain. It has the last word as to whether its mountains shall be stripped of their forests and its inhabitants shall breathe pure air.'"[28]

II. Climate Change Versus Conventional Air Pollution: Because of Fundamental Differences in Cost, Benefits and Time Horizon, Congress Did Not Intend or Anticipate the Regulation of Greenhouse Gases As "Pollutants" Under the Clean Air Act

To summarize the preceding discussion, the majority opinion in *Massachusetts v. EPA* holds: (1) that GHGs cause a kind of air pollution that can be regulated under the CAA; (2) that it is constitutionally permissible for states and private parties who believe that they will be injured by such pollution to sue to force EPA to promulgate such regulation; and (3) that EPA cannot use uncertainty over either the need for or impact of regulation as a reason for postponing making a decision. In this Part of the Article, I critically analyze these three conclusions. I undertake this analysis by asking how various legislative preferences either would or would not be furthered by having EPA regulate greenhouse gases under the CAA. This point of view allows me to consider a range of legislative preferences, asking how alternative types of federal legislators would have responded to the hypothetical question: did you intend for the CAA to include GHGs and global warming? If so, did you intend also to allow suits such as that in *Massachusetts v. EPA*, in which private parties and particular state attorneys general can legally compel the agency to act?

The approach that I take here is therefore consistent with what has become known as the purposive approach to statutory interpretation.[29] Under this approach, a judge interpreting a statute that gives somewhat vague or unclear directions on a particular point views that statute as an incomplete contract, and asks whether Congress would have wanted the statute to apply to a particular situation in a particular way.[30] If judges are pretty good at figuring out what Congress

28 *EPA*, 127 S. Ct. at 1454 (quoting *Tenn. Copper Co.*, 206 U.S. at 237).

29 For an overview of this approach to statutory interpretation, see William N. Eskridge Jr. & Philip P. Frickey, *Statutory Interpretation as Practical Reasoning*, 42 Stan. L. Rev. 321 (1990) and Philip P. Frickey, *Structuring Purposive Statutory Interpretation: An American Perspective*, 80 Australian L.J. 849 (2006).

30 *See* Frickey, *supra* note 29, at 851–53

would or would not have wanted, then through such purposive judicial interpretation, judges lower the transaction costs of legislation and further legislative goals. As summarized by one of its leading practitioners, Judge Richard Posner, on this approach (which goes by terms such as "imaginative reconstruction," or "pragmatic" statutory interpretation) judges "stick pretty close to statutory text and judicial precedent," but nonetheless interpret statutes by looking for the "actual interests at stake, the purposes of the participants, the policies behind the precedents, and the consequences of alternative decisions."[31]

While this Article is not the place for a general defense of purposive statutory interpretation, a few words are in order in defense of its application to the set of issues raised in *Massachusetts v. EPA*. As the petitioners hoped,[32] the majority opinion in that case read quite broadly and literally the statutory definition of "air pollutant"—as "'*any* air pollution agent or combination of such agents, including *any* physical, chemical . . . substance or matter which is emitted into or otherwise enters the ambient air'"—to easily include greenhouse gases such as CO_2, methane and others that are emitted into the ambient air in auto emissions.[33] Precisely because this statutory definition is so broad, however, interpreting it without even inquiring into congressional purposes in enacting the CAA can lead to absurd and perverse results that conflict with those purposes. Most fundamentally, in mandating air pollution reduction in the CAA, Congress imposed very large costs on many American regions and industries.[34] But it did so because the median member of that body (actually the vast majority of members), believed that the overwhelming majority of Americans would realize very real and tangible benefits—in the reduction and elimination of a nuisance, and in living healthier and longer lives—from incurring the costs of air pollution reduction.[35] Below I survey a

31 RICHARD A. POSNER, THE PROBLEMATICS OF MORAL AND LEGAL THEORY 208–09 (1999).

32 As the author of the petitioner's Supreme Court brief has explained, "In arguing the questions regarding EPA's authority and discretion under the [CAA], we made a tactical decision to rely almost exclusively on the text of the statute. Our thinking was as follows: First, most simply, the text of the statute clearly pointed in our direction." Lisa Heinzerling, *Climate Change in the Supreme Court*, 38 ENVTL. L. 3, 11 (2008).

33 *EPA*, 127 S. Ct. at 1460 (quoting CAA § 302(g), 42 U.S.C. § 7602(g) (2000) (emphasis added)).

34 *See* ALLEN V. KNEESE & CHARLES L. SCHULTZE, POLLUTION, PRICES, AND PUBLIC POLICY 69–83 (1975).

35 *See* CAA, § 101(a)(2), 42 U.S.C. § 7401(a)(2) (2000) ("[T]he growth in the amount and complexity of air pollution brought about by urbanization, industrial

large body of economic work that overwhelmingly shows that in the climate change world's short-to-medium term—out to 2100—few if any regions of the United States are likely to suffer serious harm from global warming, while many regions and industries may well realize modest benefits. The naïve literalist interpretation of the CAA adopted by the majority thus effectively decides that Congress also intended the CAA to require Americans to incur highly uncertain but potentially severe economic costs—the cost of reducing GHG emissions—in exchange for little or no benefit to them during this century. It is difficult to see how such a result could be squared with any reasonable construction of congressional intent in passing the CAA.

Here, therefore, I adopt the purposive approach, asking whether the interests, purposes, and policies that supported regulating conventional air pollution under the CAA would also support the regulation of GHGs under that statute.

A. Traditional Air Pollution Regulation Under the Clean Air Act

In deciding that CO_2 may constitute an air pollutant within the meaning of the CAA, the Supreme Court majority argued that the broad statutory definition of "air pollutant" as "'*any* air pollution agent or combination of such agents, including *any* physical, chemical . . . substance or matter which is emitted into or otherwise enters the ambient air'"[36] was so broad as to include "all airborne compounds of whatever stripe."[37] The Supreme Court majority in *Massachusetts v. EPA* gave this very general, vague statutory provision a very broad reading, so as to include CO_2 and other GHGs within the statutory definition of air pollution. Taking the purposive approach to

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 . . . ."); *id.* § 101 (b)(1), 42 U.S.C. § 7401(b)(1) (declaring that the purpose of the Clean Air Act is to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population"). The cost of complying with the Clean Air Act was also substantial, with the annual compliance cost exceeding $20 billion (1990 dollars) from 1974 until 1987. *See* U.S. ENVTL. PROT. AGENCY, THE BENEFITS AND COSTS OF THE CLEAN AIR ACT, 1970 TO 1990, at 8 (1997), *available at* http://www.epa.gov/oar/sect812/1970-1990/chptr1_7.pdf.

36 *EPA*, 127 S. Ct. at 1460 (quoting CAA § 302(g), 42 U.S.C. § 7602(g) (2000) (emphasis added)).

37 *Id.* The CAA also defines the national "welfare" that is to be protected by the second National Ambient Air Quality Standards discussed below as including "effects on soils, water, crops, vegetation, . . . weather, visibility, and climate." 42 U.S.C. § 7602(h) (2000).

statutory interpretation, here I ask whether this interpretative decision is consistent with the purposes of the CAA in the following, precise, sense: whether the intertemporal pattern of benefits and costs generated by regulating GHGs under the CAA is likely to be at least similar to the intertemporal pattern of costs and benefits that Congress had in mind when it regulated conventional air pollutants under that statute.

To conduct this analysis, I must briefly review how traditional air pollutants are regulated under the CAA. Although it has evolved in several ways since its passage in 1970, the heart of the CAA remains the system of National Ambient Air Quality Standards (NAAQS). NAAQS apply to conventional or, as they are called under the CAA, criteria air pollutants. The criteria air pollutants that are the focus of regulation under the CAA are lead, particulates of various diameters, sulphur dioxide, oxides of nitrogen, ground-level ozone, and carbon monoxide.[38]

All of the criteria pollutants share a very basic characteristic: as found in the lower troposphere,[39] all of these substances are pure economic bads in the sense that beyond some threshold concentration level, their presence is at least an annoying nuisance to daily life and at worst may cause adverse acute or long-term health effects as well as secondary harms such as impaired visibility in otherwise scenic areas.[40]

---

38 As explained on EPA's website,

> The Clean Air Act requires EPA to set National Ambient Air Quality Standards for six common air pollutants. These commonly found air pollutants (also known as "criteria pollutants") are found all over the United States. They are particle pollution (often referred to as particulate matter), ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead. These pollutants can harm your health and the environment, and cause property damage. Of the six pollutants, particle pollution and ground-level ozone are the most widespread health threats. EPA calls these pollutants "criteria" air pollutants because it regulates them by developing human health-based and/or environmentally-based criteria (science-based guidelines) for setting permissible levels. The set of limits based on human health is called primary standards. Another set of limits intended to prevent environmental and property damage is called secondary standards.

U.S. Envtl. Prot. Agency, Six Common Air Pollutants (Apr. 8, 2008), http://www.epa.gov/air/urbanair.

39 The lowest portion of the Earth's atmosphere. *See* Paul D. Brown, Comment, *Lofty Goals, Questioned Motives, and Proffered Justifications: Regional Transport of Ground-Level Ozone and the EPS's NO_x SIP Call*, 60 U. PITT. L. REV. 923, 928 (1999).

EPA, Six Common Air Pollutants (Apr. 8, 2008), http://www.epa.gov/air/urbanair.

40 While EPA now sets primary NAAQS to reduce harm to human health, it is important to remember that when smog—the accumulation of too much ground level ozone and unburned hydrocarbons from automobile exhaust—first became a

Pollution due to any of these substances is itself an economic bad—it has adverse effects on human health or other aspects of welfare and it lowers productivity or utility (to use economists' jargon for consumer welfare).

This focus on adverse health effects is equally true of federal regulation of new stationary sources of air pollution and of automobile tailpipe emissions under the CAA.[41] Some of these adverse impacts are acute or immediate (such as acute asthma episodes induced by very high levels of ground level ozone). Today—when ambient levels of air pollution in the United States are much lower than when the CAA was passed[42]—the benefits from continuing reductions in air pollution are mostly reductions in losses caused by premature mortality and chronic disease.[43] Thus the primary benefit that Congress anticipated from the CAA is a reduction in the probability and/or severity of adverse health outcomes suffered by the presently living generation of Americans.

The other crucial, and somewhat paradoxical, feature of the CAA is that the pollution Congress attacked in the CAA was not interregional or interjurisdictional, but primarily local. The criteria air pollutants and automobile emissions are regulated because they were perceived to be local public bads: they cause harm to human health in particular airsheds, and the amount of harm depends upon the level and type of industrial activity and the amount of automobile and truck driving that takes place in a particular airshed (or as they are called under the CAA, air quality regions), as well as upon local and regional

---

problem, it was viewed as a nuisance. For example, as late as 1971, a political scientist writing about air pollution control felt perfectly safe in saying:

> Photochemical smog remains more an irritating nuisance than a serious threat to the survival of urbanites. The nuisance has been irritating enough to provoke widespread complaints, however, especially in southern California. California officials have played an important part in inducing the automobile industry to do something about the smog problem.

MATTHEW A. CRENSON, THE UN-POLITICS OF AIR POLLUTION 9 (1971) (citation omitted).

41 Regulated, respectively, under 42 U.S.C. § 7521(a)(1), and regulations found at Control of Air Pollution from New Motor Vehicles, 65 Fed. Reg. 6698 (Feb. 10, 2000), and 42 U.S.C. §§ 7410–7431, with sixty-nine industry categories as set out in 40 C.F.R. § 60, Subpart C (2007).

42 *See* U.S. ENVTL. PROT. AGENCY, 2008 REPORT ON THE ENVIRONMENT ch. 2, 6–62 (2008), *available at* http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=190806.

43 *See* U.S. ENVTL. PROT. AGENCY, THE BENEFITS AND COSTS OF THE CLEAN AIR ACT 1990 TO 2010, at 69–75 (1999), *available at* http://www.epa.gov/air/sect812/1990-2010/fullrept.pdf.

topography.[44] Across vast areas of the United States, air pollution is not a problem. Indeed, many of the criteria pollutants—sulfur dioxide, carbon monoxide, and oxides of nitrogen—are a problem only in the most urbanized areas of the country. For example, in the vast areas encompassed by the U.S. plains states, the only criteria air pollutant that is a problem is particulate pollution in the form of dust from agriculture.[45]

Just as the levels of traditional air pollution vary greatly across different regions and metropolitan areas in the United States, so too do the benefits and costs of pollution reduction. At least in terms of health effects, places with very little pollution generally suffer lower harm from pollution, and therefore benefit less from pollution reduction, than places with lots of pollution, where the adverse health effects and benefits from pollution reduction are greater.

Of course, pollution reduction is not generally free. It is costly. In understanding the CAA, what is important is not just the total cost of achieving pollution reduction goals, but also the geographic distribution of the costs. Most importantly, the geographic distribution of the cost of pollution reduction is very different for stationary sources (industry) than for mobile sources (automobiles). This difference in the distribution of cost is a basic determinant of the structure of the CAA, explaining the way in which the CAA tries to reduce pollution from these two different types of sources.

For industrial pollution, both the benefits and costs of pollution reduction are primarily local. That is, if it is local industry that is responsible for the air pollution problem, then it is local industry and local communities that will bear the cost of pollution reduction. Given the highly localized concentration of both benefits and costs from reducing stationary source air pollution, the CAA's NAAQS are set by the federal regulator and are nationally uniform, but the states were given the job—through what are called State Implementation

44 *See* U.S. Envtl. Prot. Agency, National Ambient Air Quality Standards, General Conformity, Frequent Questions, http://www.epa.gov/air/genconform/faq.htm (last visited Nov. 5, 2008) ("The Clean Air Act identifies six common air pollutants that are found all over the United States. These pollutants can injure health, harm the environment and cause property damage. EPA calls these pollutants criteria air pollutants because the agency has developed science-based guidelines as the basis for setting permissible levels.").

45 *See* U.S. ENVTL. PROT. AGENCY, NATIONAL AIR QUALITY AND EMISSIONS TRENDS REPORT 59 (2003), *available at* http://www.epa.gov/air/airtrends/aqtrnd03 (showing how, as of September 2002, in the States of North Dakota, South Dakota, Nebraska, Minnesota, Iowa, Oklahoma, Kansas, Montana, and Wyoming there were only a handful of air pollution control areas in non-attainment with National Ambient Air Quality Standards, and then only for coarse particulates, PM_{10}).

Plans—of determining how to lower stationary source emissions so as to meet the NAAQS.[46] Notably, while EPA is not allowed to consider costs in setting NAAQS[47] (the national ambient air quality standards are supposedly based purely on health considerations), the states are allowed to consider costs in setting emission standards for existing industrial facilities that are necessary to meet NAAQS.[48]

For new industrial facilities, the CAA has since its inception required technology-based emission standards that are ostensibly uniform within particular industrial categories.[49] But neither the NAAQS nor the technology-based standards under the CAA are in fact nationally uniform. Before the law was even fully implemented, the courts construed and then Congress amended the statute to require that even areas of the country with relatively clean air (areas that were in attainment with the national ambient standards) had to meet (different) technology-based air pollution control standards (so that they could not simply pollute up to the ambient standard level).[50] And

46 *See* U.S. Environmental Protection Agency, *supra* note 44 ("Through [State Implementation Plans], States propose their strategy for reducing criteria air pollutant emissions.").

47 *See* Whitman v. Am. Trucking Ass'ns, Inc., 531 U.S. 457, 468–71 (2001).

48 Section 108(b)(1) of the CAA directs the Administrator to issue to the states "information on air pollution control techniques, which information shall include data relating to the cost of installation and operation." 42 U.S.C. § 7408(b)(1) (2000). Also, in section 109(d)(2)(C)(iv) the CAA requires that the Clean Air Scientific Advisory Commission advise the Administrator of any "adverse public health, welfare, social, economic, or energy effects which may result from various strategies for attainment and maintenance" of the NAAQS. *Id.* § 7409(d)(2)(C)(iv). As the Supreme Court explained:

> These provisions enable the Administrator to assist the States in carrying out their statutory role as primary *implementers* of the NAAQS. It is to the States that the CAA assigns initial and primary responsibility for deciding what emissions reductions will be required from which sources. It would be impossible to perform that task intelligently without considering which abatement technologies are most efficient, and most economically feasible—which is why we have said that "the most important forum for consideration of claims of economic and technological infeasibility is before the state agency formulating the implementation plan." Thus, federal clean air legislation has, from the very beginning, directed federal agencies to develop and transmit implementation data, including cost data, to the States.

Whitman, 531 U.S. at 470 (citations omitted) (quoting Union Elec. Co. v. EPA, 427 U.S. 246, 266 (1976)).

49 Mandatory federal level technology-based standards now apply both to new stationary sources, under section 111, and to hazardous air pollutants under section 112. *See* 42 U.S.C. §§ 7411–7412 (2000).

50 *See, e.g.*, Sierra Club v. Ruckelhaus, 344 F. Supp. 253, 255–56 (D.D.C. 1972), *aff'd per curiam without opinion*, 4 Env't Rep. Cas. (BNA) 1815 (D.C. Cir. 1972), *aff'd by*

although technology-based standards are tougher in areas that are heavily polluted, such areas (called nonattainment areas) have been given more and more time to meet the NAAQS—so much time that the statutory deadlines have come to have very little meaning.[51] All in all, when it comes to stationary sources of air pollution—industry—Congress has been relatively deferential to the states and to the local cost of air pollution reduction.[52]

With mobile sources, the geographic distribution of costs and benefits is different, and so too is the CAA regulatory structure. The problem of smog—low level ozone—and other pollution from automobile exhausts first became a problem in California, and as early as 1959, California had passed state legislation regulating automobile tailpipe exhaust emissions.[53] During the 1940s and 50s, however, auto pollution was a major problem in relatively few American metropolitan areas, and although virtually the entire California delegation

an equally divided Court sub nom. Fri v. Sierra, 412 U.S. 541 (1973). When legislation was introduced to amend the law in 1976, it clearly reflected the stark differences in the regional costs and benefits of air pollution control: the nation was divided into areas based upon the existing level of ambient pollution, with different degrees of increases in pollution allowed, depending upon the ambient level (with increases limited even in areas that already were in attainment, the so-called Prevention of Significant Deterioration (PSD) provisions). *See* CHRISTOPHER J. BAILEY, CONGRESS AND AIR POLLUTION 190–91 (1998). Senators from western and southern states immediately challenged the PSD provisions. A senator from Utah said: "The issue is not a clean air or dirty air issue: it is more a growth or no-growth issue." *Id.* at 191. A representative from Florida argued that the PSD provisions could have a "profound effect on our economy, severely limit potential jobs, create incentives for our basic industries to locate abroad and further retard our efforts toward energy self-sufficiency," and a House amendment to delete the PSD provisions from the bill was only narrowly defeated. *Id.* at 192.

51 The Clean Air Act Amendments of 1977, Pub. L. No. 95-95, 91 Stat. 685 (codified as amended at 42 U.S.C. §§ 7401–7671q (2000)), were motivated in large part by the widespread failure of states to meet the attainment deadlines of the 1970 CAA. The 1977 Amendments created the concept of a "nonattainment area"—an area where air quality falls short of the NAAQS. Clean Air Act Amendments of 1977 § 171(2), 42 U.S.C. § 7501(2). Congress extended the deadline for attainment of the primary NAAQS in a nonattainment area to December 31, 1982. *Id.* § 172(a)(1), 42 U.S.C. § 7502(a)(1). Congress additionally allowed states to get further extensions for "photochemical oxidants" (ozone) and carbon monoxide if they could show that attainment was not possible by 1982 but would be achieved as "expeditiously as practicable" but not later than December 31, 1987. *Id.* § 172(a)(2), 42 U.S.C. § 7502(a)(2).

52 Moreover, since its passage in 1970, the CAA has left the regulation of old stationary sources that were built prior to 1970 entirely to the states (at least for conventional, non-hazardous pollutants). *See* CRAIG N. JOHNSTON ET AL., LEGAL PROTECTION OF THE ENVIRONMENT 268 (2d ed. 2007).

53 *See* JAMES E. KRIER & EDMUND URSIN, POLLUTION AND POLICY 127–69 (1977).

annually pushed for federal legislation dealing with the problem of air pollution from automobile exhaust, they had no success.[54] Federal legislation dealing with automobile exhaust emissions did not occur until the 1960s, when the smog problem had spread to a number of other major metropolitan areas in the United States.[55] While the problem of automobile pollution became national in scope—arising in more and more heavily populated metropolitan areas—the production of mobile sources (cars and trucks) has always been heavily concentrated in the upper Midwest.[56] Since the cost of reducing automobile exhausts has always been geographically concentrated, at least relative to stationary source pollution, it is perhaps not surprising that the primary focus of attention when the CAA was passed in 1970 was in fact automobile emissions, and that Congress found it much easier to agree on national exhaust emission standards than on national industrial pollution standards. The structure of federal exhaust emission legislation was in fact set way back in 1967: all states other than California must meet national automobile emission standards; California, and only California, is allowed to set auto emission standards tougher than those set by the federal EPA.[57] Federal exhaust emission standards are technology based, and require a mix

54 *See* BAILEY, *supra* note 50, at 86–103.

55 *See id.* at 103–08.

56 In 1967, for example, a full sixty-five percent of U.S. automobile industry employment was located in the three Midwest States of Ohio, Michigan, and Indiana. *See* Fed. Reserve Bank of Chicago, Automotive Wages in Flux (July 18, 2007), http://midwest.chicagofedblogs.org/archives/2007/07/wages_in_automo.html. Since 1990, auto industry jobs have steadily shifted from this area of the country, which has lost roughly 200,000 auto industry jobs during this period, to the South, which has gained about 180,000 jobs during the same period. Sean P. McAlinden, Vice President of Research Center for Automotive Research, There's No Place Like Home (Apr. 19, 2006), http://chicagofed.org/news_and_conferences/conferences_and_events/files/2006_auto_mcalinden.pdf. Indeed, the relatively strong growth rate of U.S. automotive manufacturing during the 1990s was primarily due to increased output from new plants in the southern United States owned by foreign-based manufacturers. *See* STEPHEN COONEY & BRENT D. YACOBUCCI, CONG. RESEARCH SERV., U.S. AUTOMOTIVE INDUSTRY 36–49 (2005).

57 This was despite the efforts of Representative John Dingell from the auto manufacturing State of Michigan. California—which had set the first auto emission standards—was allowed under the 1967 law to set stricter auto emission standards than those set by the federal government. *See* BAILEY, *supra* note 50, at 134–35. Through Senator Edmund Muskie's efforts, what was to become the CAA of 1970 set a 1975 deadline for a ninety percent decrease in automobile emissions; the political power of the automobile industry was nonetheless such that its congressional allies got the only serious concession made by Muskie in the 1970 law: provisions allowing the automobile manufacturers to request extensions to the deadlines for carbon monoxide and hydrocarbons. *Id.* at 151–55.

of combustion and post-combustion controls designed to reduce emissions of carbon monoxide, nitrogen oxides, unburned hydrocarbons (or a subset thereof, volatile organic compounds), and particulate matter from diesel engines.[58]

The CAA is thus an enormously complex statute whose complexity in large part reflects the varying costs and benefits of reducing criteria air pollutants in different states and localities. In the CAA, Congress' intent was indeed to improve ambient air quality by reducing emissions of certain pollutants. But the way Congress went about achieving that general goal in the CAA closely reflected the varying political and economic costs and benefits of air pollution control in different regions of the country. The CAA's distinction between attainment and nonattainment areas effectively permitted more rapid economic development in regions that had high air quality in 1970 than in those that already had poor air quality at that time.[59] Yet even in nonattainment areas, by giving states the job of implementing and enforcing the law, the CAA consistently recognizes interstate variation in and the practical need to consider the social and economic costs of air pollution reduction. Even in its more purely federal approach—nationally uniform federal technology-based auto emission standards—the CAA recognizes interstate variation in costs and benefits by allowing states to regulate more stringently than federally required whenever California—which had the first and most severe local auto pollution problem—decides to do so first. Moreover, the harms that the CAA seeks to reduce are primarily health harms to the present generation of Americans. The CAA did indeed impose costs, but it did so to provide present and future health benefits to currently living Americans. Crucially, most of the jurisdictions where there were big costs—such as the midwestern Rust Belt and heavily developed northeastern corridor—also got big benefits from reducing air pollution.

Hence in its actual application, the CAA has generated an outcome with varying levels of ambient air quality that roughly (admittedly only very roughly) reflect local and regional costs and benefits of air pollution reduction. In asking whether the CAA should be inter-

58 *See generally* Arnold W. Reitze, Jr., *Mobile Source Air Pollution Control*, 6 ENVTL. LAW. 309, 321–25, 338–43 (2000) (explaining vehicle emission control systems for exhaust emissions and federal exhaust emissions standards).

59 Michael Greenstone, *The Impacts of Environmental Regulations on Industrial Activity*, 110 J. POL. ECON. 1175, 1178 (2002) (finding that across a very broad sample of pollution-intensive industries, in the first fifteen years in which the CAA was in force, 1972 to 1987, relative to attainment counties, nonattainment counties lost approximately 590,000 jobs, $37 billion in capital stock, and $75 billion (in 1987 dollars) of output).

preted to apply to GHGs, the relevant question (from the point of view of purposive statutory interpretation) is: does the magnitude and interstate distribution of costs and benefits from reducing GHGs so resemble that from reducing conventional air pollutants that it is reasonable, or even plausible, to think that the federal legislators who voted in favor of incurring present-day costs in order to reduce traditional air pollution and thereby confer health benefits upon the present generation of Americans (the CAA "deal") would have also voted to regulate GHG emissions under that statute?

B. The Geographic and Intertemporal Distribution of U.S. Costs and Benefits from Global Warming Is Radically Different from the Costs and Benefits from Traditional Air Pollutants: Congress Could Not Have Intended to Regulate GHGs Under the Clean Air Act

The answer the question posed at the end of subpart A is, I believe, clearly "no," for the simple reason that the pattern of costs and benefits from regulating GHGs under the CAA is likely to be radically different from the pattern of costs and benefits generated by the regulation of traditional air pollutants under that Statute. The impact of GHGs on American society is strikingly different from the traditional pollutants regulated under the CAA. Greenhouse gases are to be regulated not because of any direct local health effect, but because their accumulation at various concentrations in the atmosphere is causing the global climate to warm, and it is believed that this warmer global climate will in turn have adverse impacts for particular places both within and outside of the United States. Aside from its separate treatment of the stratospheric ozone problem,[60] the CAA is not concerned with international air pollution.[61] Therefore, if one is to jus-

60 Title VI of the CAA, "Stratospheric Ozone Protection," is found at 42 U.S.C. §§ 7671–7671q (2000). As lucidly explained by RICHARD ELLIOT BENEDICK, OZONE DIPLOMACY 111–13 (1991), U.S. companies such as DuPont did not actively oppose the phase-out of the most serious ozone depleting refrigerants, at least relative to their European competitors, in large part because they achieved leadership in producing substitutes.

61 Indeed, it was only after Congress added a separate and quite different program—the Title IV acid rain trading program—that the CAA successfully addressed even a regional air pollution problem. *See* BAILEY, *supra* note 50, at 230–38. The acid rain problem was not even discussed by Congress until after the 1977 amendments. *See id.* at 210. In Congress, acid rain control starkly pitted the interests of some regions of the country against others, with politicians from northern and northeastern states recounting the damage acid rain had done to their states' lakes rivers and forests, while those from midwestern and Appalachian coal-producing states argued that there was not sufficient evidence that coal was the problem. *See id.* at 214–27. Support for tougher sulfur dioxide emission limits came from representatives and

tify the regulation of GHG emissions as a form of air pollution under the CAA, then it must be because of the adverse impact on the United States from global warming. However, unlike traditional air pollutants, which are a local public bad everywhere, GHG emissions are not an economic bad everywhere within the United States. Indeed, there is a large body of economic evidence which suggests that in the short-to-medium term (up to at least 2050), for many regions within the United States, the climate changes induced by the accumulation of CO_2 and other GHGs in the atmosphere (troposphere) will generate net benefits, rather than net costs.[62] For such regions, climate change will be an economic good, not an economic bad. The CAA has nothing to do with the regulation of "pollution" that is likely to be a short-to medium-term economic good for many regions of the United States.

It is of course true that if in the longer term (late twenty-first century and beyond), GHG emissions do not decline or at least stabilize, climate changes are possible which will in fact harm most regions of the United States.[63] However, there is so much uncertainty associated with such long-term climate change that it is very difficult to imagine how the CAA could possibly be interpreted as intended to regulate such long-term, and highly uncertain, harms from climate change. Thus, my argument is that if global warming will generate a variegated pattern of costs and benefits to the United States, with only some regions of the country being net losers from global warming in the short-to-medium term, then the legislative bargain that sustained mandatory emissions standards for automobile emissions in the CAA cannot by any reasonable stretch of the imagination be interpreted to extend to mandatory emission standards for CO_2.

---

senators from states in the Northeast; opposition came from congressional members from states in the Midwest and Appalachia that produced coal with a high sulfur content. *See id.* Throughout the 1980s, Congress remained deadlocked on the issue, and resolution did not come until strong presidential leadership helped usher in the cost-effective compromise represented by the acid rain trading program of Title IV in the 1990 amendments. *Id.* at 209–37.

62 *See infra* Part II.C.

63 *See* U.S. GLOBAL CHANGE RESEARCH PROGRAM, CLIMATE CHANGE IMPACTS ON THE UNITED STATES 6–11 (2001), *available at* http://www.usgcrp.gov/usgcrp/Library/nationalassessment/00Intro.pdf (discussing likely negative impacts that global climate change will have on the United States).

C. The Short-to Medium-Term Benefits to the United States from a Warmer (and Generally Wetter) Climate

In the short-to-medium term—by which I mean the twenty-first century—average daily temperature increases in the two to three degree centigrade range[64] will almost surely generate net benefits in many areas of the United States.[65] Most directly and most surely, a warmer climate with milder winters will confer a very large amenity benefit: economic studies have consistently shown that people are willing to pay a premium to live in places with warmer weather. Somewhat less certain benefits from a warmer and wetter climate include boosts to agricultural production and health benefits. Much less certain is the possibility that by increasing the frequency of El Niño events, global warming will reduce the cost of hurricanes to the United States. Of course, global warming may also increase the severity of coastal storms. Storms are of course costly, but recent empirical work shows that due to continuing adaptation, there has been a steady and rapid decline in U.S. losses from coastal and other natural hazards. Here I briefly review the evidence on all of these points.

1. The Amenity Value of a Warming U.S. Climate

The amenity value that people attach to different climatic regimes is hardly a new topic. It has been intensively studied for decades by public finance and urban economists. Climate varies with location, and there are very important and intensively studied markets—for real estate and for jobs—which carry information about the value that people attach to different locations and hence different cli-

64 Temperature increases in this range are predicted for the end of the century (2070–90) for so-called "business as usual" (no carbon tax) scenarios (the IPCC's A1F1 scenario and the A2 scenario) by two of the most widely used Ocean-Atmosphere Global Climate Models (OAGCM), the Hadley Centre's 3rd OAGCM and the National Center for Climate Research's Community Climate System Model 3. *See* Olivier Deschênes & Michael Greenstone, *Climate Change, Mortality, and Adaptation: Evidence from Annual Fluctuations in Weather in the U.S.* 3, 39 (MIT Dep't of Econ., Working Paper No. 07-19, 2007), *available at* http://ssrn.com/abstract=995830.

65 I am not alone in this empirical observation, but this is to my knowledge the first time that the various pieces of evidence have been summarized for legal policymaking. *See* Cass R. Sunstein, *The Complex Climate Change Incentives of China and the United States* 11, 12 (AEI-Brookings Joint Ctr. for Regulatory Studies, Working Paper No. 07-14, 2007), *available at* http://aei-brookings.org/admin/authorpdfs/redirectsafely.php?fname=../pdffiles/WP07-14_topostv1.pdf (observing that even with a worst-case three degree centigrade increase in global mean temperature, the United States will face relatively little cost from climate change, while Russia is actually expected to benefit from such a temperature increase).

mates. It is well known that both wages and salaries and home prices vary a great deal with location. For example, in 2006, the median price of an existing single family home in the most expensive U.S. markets, such as San Francisco and Boston, was many, many times what the median price was in midwestern and Rocky Mountain metropolitan areas such as Cincinnati, Cleveland, Denver and Des Moines.[66] Now, of course, locations vary in lots of dimensions other than climate that economists predict would determine median home prices and wages, such as median income and wealth, unemployment rate, and the quality of local schools.[67] Some of these predictions—such as the prediction that metropolitan areas with higher median income should also have higher median home prices—have been difficult for economists to empirically corroborate.[68] But what the studies have consistently found is a result of striking importance for the normative evaluation of alternative climates: that people have a strong and robust willingness to pay for local climates that are mild.[69]

66 As reported by the National Association of Realtors, median sales prices of existing single family homes as of 2006 for the exemplar cities in the text ranged from $753,000 and $402,000 for San Francisco and Boston, respectively, to $250,000 for Denver, $145,000 for Des Moines, $143,000 for Cincinnati, and $134,000 for Cleveland. *See* Nat'l Ass'n of Realtors, Metropolitan Median Prices, http://www.realtor.org/Research.nsf/Pages/MetroPrice. For data on interurban wage variation, see Jennifer Roback, *Wages, Rents, and the Quality of Life*, 90 J. POL. ECON. 1257, 1268–72 (1982).

67 For an introduction to the methods that economists have developed to isolate the effect of particular locational variables on market values, see Raymond B. Palmquist, *Property Value Models*, *in* 2 HANDBOOK OF ENVIRONMENTAL ECONOMICS 763, 766–83 (Karl-Göran Mäler & Jeffrey R. Vincent eds., 2005).

68 *See* Michael J. Potepan, *Explaining Intermetropolitan Variation in Housing Prices, Rents and Land Prices*, 24 REAL EST. ECON. 219, 219–23 (1996).

69 *See, e.g.*, Glenn C. Blomquist et al., *New Estimates of Quality of Life in Urban Areas*, 78 AM. ECON. REV. 89, 97–104 (1988); Joseph Gyourko & Joseph Tracy, *The Structure of Local Public Finance and the Quality of Life*, 99 J. POL. ECON. 774, 782 (1991) (finding that while precipitation, humidity, sunshine, and cooling degree days are statistically insignificant, heating degree days are significant, with an estimated annual full price—lower housing prices but higher earnings—of living in a cold climate of $22.58 for each one percent rise in heating degree days). There are various definitions of climatic "mildness." *Compare* Blomquist et al., *supra*, at 104 tbl. 4 (calculating "climate" value by considering implicit prices resulting from "precipitation, humidity, heating degree days, wind speed, sunshine, and coast"), Gyourko & Tracy, *supra*, at 779 (same), *and* Roback, *supra* note 66, at 1270 (same), *with* Potepan, *supra* note 68, at 235 (adopting the climate mildness index set forth in the *Places Rated Almanac*), *and* Christopher A. Manning, *Explaining Intercity Home Price Differences*, 2 J. REAL EST. FIN. & ECON. 131, 146 (1989) (same). But as discussed below, the finding that climate is significant and that in particular people have high willingness to pay for a mild, warm climate is consistent, regardless of the particular measure of climatic mildness

That people value mild climates has been a consistent finding in the literature for over at least the past two decades. Some recent studies give some concrete dollar figures for just how much people value climate mildness, and also clarify how demographic differences in age and education affect how people value different aspects of climate "mildness." In a carefully constructed study using extensive microdata on households, Michael I. Cragg and Matthew E. Kahn found that both college educated and non-college educated Americans place a very high value on climate, with the attribute most valued being warmer winters (measured by average February temperature).[70] They found that college graduates were willing to pay $1200 for a 10.4° centigrade (or one standard deviation) increase in average February temperature, with older college graduates (aged 50–60) willing to pay even more ($10,000), and non-college graduates in the same age group willing to pay still more ($60,000), for warmer winters.[71] As income typically increases with age, Cragg and Kahn take the strong positive age dependency of climate valuation to indicate that climate is a normal good—that is, that demand for climatic mildness increases with income.[72] Other attributes of climatic mildness were also valued: college graduates aged 50–60, for example, were willing to pay $4400 for one standard deviation less rain, $5800 for one standard deviation lower July temperature, and $3900 for one standard deviation less humidity.[73]

Other studies have used different measures of climate mildness. For example, in his study of intermetropolitan area variation in house prices, Christopher A. Manning used as his climate mildness variable the index of climate mildness published in the Rand McNally *Places Rated Almanac*.[74] On this index, the "best" (that is, highest scoring on climate "mildness") climates are California coastal Mediterranean

---

used. *See infra* notes 70–74 and accompanying text. In addition to Roback, *supra* note 66, at 1270, see Sherwin Rosen, *Wage-Based Indexes of Urban Quality of Life*, *in* CURRENT ISSUES IN URBAN ECONOMICS 74, 96 (Peter Mieszkowski & Mahlon Straszheim eds., 1979); Philip E. Graves, *Migration and Climate*, 20 J. REG'L SCI. 227, 234 (1980); and Stephen M. Renas & Rishi Kumar, *Climatic Conditions and Migration*, 17 ANNALS REG'L SCI. 69, 76 (1983) (finding that people tend to migrate toward areas with relatively mild climates).

70 Michael Cragg & Matthew Kahn, *New Estimates of Climate Demand: Evidence from Location Choice*, 42 J. URB. ECON. 261, 277 (1997).

71 *Id.* at 277–78.

72 *Id.* at 277.

73 *Id.* at 278.

74 *See* Manning, *supra* note 69, at 146 (utilizing the climate mildness index set forth in the Places Rated Almanac. DAVID SAVAGEAU, PLACES RATED ALMANAC 24, 501–19 (7th ed. 2007)).

places such as San Francisco, followed by snowless Pacific Northwest climates, desert climates (Yuma, Arizona, for instance, ranks very high on this index), beach climates (mainly in Florida), and long-hot-summer climates (such as is found in central Texas).[75] Indeed, the top fifty climates are all either in the Sunbelt or on ocean coastlines.[76]

Studies of how climate (and weather) affects interregional migration and wage variation have used different measures of climate, but like the studies of climate and house prices, the migration and wage studies have consistently found that climate is very important in explaining interregional migration and wage variation.[77] Jennifer Roback's pathbreaking application of the hedonic pricing approach generated not only the general result that regional wage differences could be explained "largely" by variations in local amenities, but that climate was a "remarkably" important amenity.[78] She found that people view a cold, snowy, and cloudy local climate as a very strong disamenity for which they demand compensation in the form of higher wages, while the number of sunny days was by contrast a very powerful amenity, lowering the wage that employers must pay to attract employees.[79] Studies of migration have generally painted a similar picture, finding for example that people migrate away from places with climates that are severe in the sense of having a large variation between summer maximums and winter minimums.[80]

Especially given the fact that varying climate measures are used, the consistent finding from the economic literature on intermetropolitan variation in house prices, wages, and migration—that people are willing to pay significantly more for houses and to work for significantly less in locations that have relatively warm climates—is quite remarkable. That same literature reveals that what people dislike in a climate is large seasonal variation in temperature and precipitation, especially when that variation means cold and snowy winters.[81] If the ensemble of Ocean Atmosphere General Circulation Models

75 *See* SAVAGEAU, *supra* note 74, at 501–19.

76 *See id.*

77 *See* Graves, *supra* note 69, at 233; Roback, *supra* note 66, at 1270.

78 Roback, *supra* note 66, at 1270.

79 *Id.*

80 *See* Graves, *supra* note 69, at 233. Interestingly, like Cragg and Kahn, Graves found that response to climate is highly age dependent, finding, for example, that warmth (defined as average annual cooling degree days) is a big draw for people older than fifty-five but is of (statistical) insignificance to younger people. See Cragg & Khan, *supra* note 70, 277–78; Graves, *supra* note 69, at 233–34.

81 *See, e.g.*, Cragg & Kahn, *supra* note 70, at 278.

(OAGCM) used by the IPCC is correct in predicting that climate change will mean that many regions of the United States will be warmer, especially in the winter, then for such regions, climate change may bring precisely the kind of climate that people like. Rather than being places to flee from, northern regions of the country may instead be places that people migrate toward. Moreover, those regions that are predicted to become both warmer and much more subject to drought (such as the Southeast) may indeed suffer declines in agricultural yield, but they will also resemble more the desert metropolitan areas that, as the economic literature predicts, are currently the fastest growing areas in the entire United States.[82]

It is true that people in regions with warmer and hence more desirable climates will not enjoy a free lunch. On the margin, areas with warmer, more desirable climates will attract more immigrants (and lose fewer emigrants), and therefore housing prices in such places will tend to rise relative to places with worsening climates.[83] Of course, insofar as global warming may mean that most places in the United States will have milder winters, the value of a mild winter will tend to fall (by the basic law of supply and demand). Moreover, the effects of a warming climate are not expected to be positive everywhere: places that are now quite cold would increase in value by more than average, whereas hot places could decrease in value.[84] Still, moderate (two degree centigrade) climate change will have generated what is essentially a large scale local public good: a "free" warming of local climates (free in the sense that it was not paid for in local taxes) that may be worth as much as $75 billion.[85]

And even this number may be an underestimate. Recent evidence shows that over time, the value of climate (as with other public goods) has been increasing.[86] Between 1940 and 1990, the U.S. popu-

82 The most recent census data reveals that nine of the ten U.S. counties with the biggest population gains over the 2000 to 2006 period were in the South or West, with half of those with the biggest gains located in Texas; the biggest absolute population increase was in Maricopa County in Arizona (growing by 700,000 people since 2000, or by more than the population of all but fifteen American cities), and the largest growth rate was in Flagler County in northeastern Florida, with growth of sixty-seven percent since 2000. *See* Sam Roberts, *Census Reports Arizona County Still Has Biggest Growth*, N.Y. TIMES, Mar. 22, 2007, at A18.

83 A point made by Matthew E. Kahn, *Environmental Valuation Using Cross-City Hedonic Methods* 5 (Draft of June 2004), *available at* http://ssrn.com/abstract=556739.

84 Robert Mendelsohn, *A Hedonic Study of the Non-Market Impacts of Global Warming in the U.S.*, *in* THE AMENITY VALUE OF THE GLOBAL CLIMATE 93, 104 (2001).

85 *Id.* at 105.

86 *See* Dora L. Costa & Matthew E. Kahn, *The Rising Price of Nonmarket Goods*, 93 AM. ECON. REV. 227, 227 (2003).

lation moved south and west, and wealthier and older people with the means to "buy" warmer climate through their locational choices clearly did so.[87] Cragg and Kahn find that whereas in 1960 and 1970 places with warmer February temperatures actually had lower real estate rental prices, by 1990, warm February temperatures were capitalized into higher real estate rents.[88] In related work, Dora L. Costa and Matthew E. Kahn find that whereas in 1970 a person would have had to pay $1288 (in 1990 dollars) to buy San Francisco's climate instead of Chicago's, by 1990 this differential had increased to $7547.[89] In summary, recent empirical findings indicate that over the time period 1940 to 1990, the price of warm climate (measured by February average temperatures) has been increasing in terms of both rising rental prices and falling earnings.[90]

2. Health and Recreational Benefits to the United States from a Warming Climate

The relationship between climate—and especially temperature—and human morbidity and mortality is not a new topic, having been studied for over a century.[91] In industrialized countries, mortality peaks in the winter, mainly from noncommunicable diseases (such as heart disease).[92] This suggests that the warmer, wetter conditions pre-

87 *See* Michael I. Cragg & Matthew E. Kahn, *Climate Consumption and Climate Pricing from 1940 to 1990*, 29 REG'L SCI. & URB. ECON. 519, 521–22 (1999).

88 *See id.* at 529. Somewhat non-intuitively, they also find that across the entire 1940–1990 period, humidity was positively capitalized into rents. *Id.*

89 Costa & Kahn, *supra* note 86, at 231.

90 *See* Cragg and Kahn, *supra* note 87, at 536 (stating "there has been a rise in rental capitalization" and "earnings capitalization has declined"). The exception seems to be for southern earnings, which have not fallen. As noted below, *infra* note 118, this is likely a function of air conditioning, which has significantly increased labor productivity in the South. It is worth noting that the preference for warm and sunny climates is not limited to U.S. households, but is a robust and highly statistically significant finding of studies of many other countries: indeed, David Maddison concludes that "[m]ost of the countries in Europe and North America" would "benefit substantially from an increase in temperature." David Maddison, *The Amenity Value of the Climate: The Household Production Function Approach*, *in* THE AMENITY VALUE OF CLIMATE, *supra* note 84, at 25, 35.

91 COMM. ON SCI., ENG'G, & PUB. POLICY, POLICY IMPLICATIONS OF GREENHOUSE WARMING 616 (1992).

92 Most recently, perhaps, Deschênes and Moretti find "evidence of a large and statistically significant permanent effect on mortality of cold waves." Olivier Deschênes & Enrico Moretti, *Extreme Weather Events, Mortality and Migration* 26 (Nat'l Bureau of Econ. Research, Working Paper No. 13227, 2007), *available at* http://ssrn.com/abstract=998010. This effect appears to be larger than the immediate effect, possibly because it takes time for health conditions associated with extreme cold to

dicted for the northern region of the United States will not only mean enhanced agricultural productivity for that region, but also (as with El Niño events discussed below) a likely substantial reduction in lives lost due to severe winter weather.[93]

That a warmer climate, with milder winters, will bring clear health benefits to the United States is buttressed by recent work showing how in the United States, heat-related mortality has steadily declined over the period from the 1960s to the late 1990s, with an average number of excess deaths on hot and humid days dropping (in a sample of twenty-eight major American cities) from forty-one during the 1960s to 1970s to a little over ten in the 1990s.[94] A number of factors seem to account for the secular decrease in heat-related mortality in the United States since the 1960s: improvements in medical care and technologies, improved public health systems that warn people about coming heat waves, and even human biophysical acclimatization to high temperatures.[95] Perhaps most striking and significant, however, has been the impact of air conditioning. By the 1980s, many cities in the southern United States (such as Houston, Miami, and Charlotte) had no elevated mortality on hot and humid days, and over the entire period from the 1960s to the 1990s, the impact of hot and humid days on mortality was weakest in cities in the southern United States—the warmest and most humid cities, but also places where air conditioning use is most widespread.[96] Indeed, reflecting the huge

---

manifest themselves and to spread. *See* COMM. ON SCI., ENG'G, & PUB. POLICY, *supra* note 91, at 616 (citing Wolf H. Wiehe, *Climate, Health and Disease*, *in* PROCEEDINGS OF THE WORLD CLIMATE CONFERENCE, 311, 336–48 (World Meteorological Org. ed., 1979)); Robert E. Davis et al., *Changing Heat-Related Mortality in the United States*, 111 ENVTL. HEALTH PERSP. 1712, 1713 (2003). For some specific studies, see, for example, G. Laschewski & G. Jendritzky, *Effects of the Thermal Environment on Human Health: An Investigation of 30 Years of Daily Mortality Data from SW Germany*, 21 CLIMATE RES. 91, 93–100 (2002); Alexander Lerchl, *Changes in the Seasonality of Mortality in Germany from 1946 to 1995: The Role of Temperature*, 42 INT'L. J. BIOMETEOROLOGY 84, 84–87 (1998). In developing countries, by contrast, mortality peaks in the summer, primarily from infectious diseases. *See* COMM. ON SCI., ENG'G, & PUB. POLICY, *supra* note 91, at 616 (citing Wiehe, *supra*, at 336–48).

93 Although the causes are not yet understood, in "nearly all cities examined globally," winter mortality is "much higher" than summer mortality. Robert E. Davis, *Climate Change and Human Health*, *in* SHATTERED CONSENSUS 183, 191 (Patrick J. Michaels ed., 2005). Hence lives lost to global warming–induced summer excess heat events might be outweighed by lives saved due to global warming–induced warmer winters. *See Id.*

94 Davis et al., *supra* note 92, at 1714.

95 *Id.* at 1717.

96 *Id.* at 1715–16. Perhaps the most striking finding on the impact of air conditioning comes from studies of the impact of air conditioning on mortality during the

impact of air conditioning in allowing people to consume warm winters without suffering so much from hot and humid summers, Cragg and Kahn find that while in 1960 workers were compensated in the form of higher earnings for living in places with hot summers, by 1990 there was no compensating wage differential for living in such hot and humid places.[97]

Of course, to accurately measure the impact of weather on health in the United States, one must control for the massive population shift to the better-adapted southern states that has occurred over the last thirty years.[98] Even using two General Circulation Models (GCM) that predict a huge increase over the 2070 to 2099 period in very hot days[99] but very little decline in the number of very cold days,[100] a recent study that does precisely this finds that for most demographic groups in the United States, there will be no statistically significant increase in mortality due to such temperature increases.[101] Moreover, the estimated mortality functions in this study are U-shaped, with mortality highest at the very warmest and coldest daily (mean) temperatures.[102] The estimated temperature-mortality relationship implies that under alternative but plausible climate change scenarios, where warming is concentrated most in the coldest months, warming would lead to a "substantial" reduction in mortality.[103]

This evidence does not imply that everyone can equally adapt to a warming climate,[104] nor does it imply that adaptation is costless.[105]

1995 Chicago heat wave. These studies found that moving from an unventilated indoor location to an air conditioned location reduced the individual mortality risk by a factor of five or six (that is, 500–600%). *See, e.g.*, Nathan Y. Chan et al., *An Empirical Mechanistic Framework for Heat-Related Illness*, 16 CLIMATE RES. 133, 138–39 (2001).

97 Cragg & Kahn, *supra* note 87, at 527–29.

98 For example, over the period from 1968 to 2002, Arizona's population increased by 223%, compared to just 124% for other states in its Census Division. *See* Deschênes & Greenstone, *supra* note 64, at 21.

99 The U.S. estimate included an increase in the average number of days with a mean daily temperature above ninety degrees from just 1.7 to 44. *See id.* at 44 fig.2, 45 fig.3.

100 For the United States, the GCMs predicted an average decline of only three to eight days with a mean temperature below thirty degrees Fahrenheit. *See id.*

101 *Id.* at 26.

102 *Id.* at 27.

103 *Id.*

104 Deschênes & Greenstone find, importantly, that the vast increase in very hot days predicted by the Hadley Centre GCM and NCAR's GCM would cause an increase in the infant mortality rate, by 5.5% for females and 7.8% for males. *Id.* at 25.

105 Indeed, Deschênes & Greenstone predicted that as people adapt to climate change by installing more air conditioning, switching fuels and redesigning buildings,

What it shows is that for the average resident of developed, industrialized countries, a warmer climate will bring net health benefits rather than any significant health costs.[106]

In the United States, a warmer climate will likely not only bring health benefits, but also quite sizeable recreational benefits. Early studies of the impact of climate warming in the 2.5° centigrade range focused on skiing and unsurprisingly found that a warmer climate would mean a potentially large decrease in ski days and a correspondingly large welfare loss.[107] But skiing is of relative economic insignificance compared to summertime recreational activities such as boating, camping, fishing, golfing, hunting, and wildlife viewing, with only $2.5 billion spent annually on skiing, compared to $76 billion on the summertime activities.[108] With either a modest 2.5° centigrade increase, or an even larger 5° centigrade increase in temperature, recent economic work estimates very large net recreational benefits from global warming in the United States, with net benefits perhaps reaching over $25 billion under the five degree increase scenario.[109]

3. Market Adaptation to Extreme Weather Events and the Continuing Increase in Value of and Decreased Human Risk in U.S. Coastal Locations

As just discussed, air conditioning has proven to be an enormously effective adaptation in allowing residents of very warm southern and southwestern regions of the United States to enjoy the benefits of a warm climate while lessening the adverse health consequences from heat waves. It may well be pointed out that many models of climate change predict that in most parts of the United States, a warmer and wetter climate will also be much stormier, with an increase in the frequency of torrential rains, tornadoes, and similar severe weather. The models do not predict future widespread Mediterranean mildness in the United States, but rather something like a

---

there will be a statistically significant increase in energy consumption of between fifteen and thirty-five percent. *Id.* at 34.

106 It has been estimated that a 2.5° centigrade rise in average U.S. temperatures would cut annual deaths by between 37,000 and 41,000. Thomas Gale Moore, *Health and Amenity Effects of Global Warming*, 36 ECON. INQUIRY 471, 475, 478 (1998) (researching these numbers based on studies of mortality in Washington, D.C. and in 89 large U.S. counties).

107 *See* Robert Mendelsohn & Marla Markowski, *The Impact of Climate Change on Outdoor Recreation*, *in* THE IMPACT OF CLIMATE CHANGE ON THE UNITED STATES ECONOMY 267, 268 (Robert Mendelsohn & James E. Newmann eds., 2004).

108 *Id.*

109 *Id.* at 283.

much stormier and more unpredictable version of the climate that now prevails in the southeastern United States. Finally, critics may stress that global warming will also entail rising sea levels (due both to the direct effect of a warmer atmosphere, and hence oceans, and to melting ice caps) and increasingly severe hurricanes—developments that will make the mild, coastal climates that Americans now seem to most prefer much less attractive places to live.

Let us assume that the criticism stated a moment ago is correct: that even if climate change makes much of the United States warmer and less snowy and therefore more attractive to many people, it will also make ocean coastal areas much more subject to hurricanes and coastal storms. A very basic economic prediction is that as people come to expect increased storms in certain locations, they will come to subtract the expected loss due to such storms from the price they are willing to pay for homes.[110] There is evidence for such rational discounting of home prices.[111] There is also evidence for the related and equally plausible conjecture that even for hurricanes, one or two occurrences of such a storm event does not cause people to immediately evaluate upward their expected loss. Rather, it may take a somewhat sustained increase in the number of such random natural disasters before people decide that the probability of such a disaster has increased and for them to consequently increase their estimated expected losses, and to (permanently) discount the price they are willing to pay for homes in locations that have been subject to such repeat strikes.[112]

---

110 *See* Colin F. Camerer & Howard Kunreuther, *Decision Processes for Low Probability Events: Policy Implications*, 8 J. POL'Y ANALYSIS & MGMT. 565 (1989) (arguing that hurricanes and other catastrophic natural disasters are precisely the sort of low probability–vast harm events that people have difficulty in rationally and quantitatively evaluating). This is an alternative explanation of empirical findings, discussed below, that people do not discount by much the price they are willing to pay for housing in locations subject to such risks.

111 *See, e.g.*, Don N. MacDonald et al., *Uncertain Hazards, Insurance, and Consumer Choice: Evidence from Housing Markets*, 63 LAND ECON. 361, 369–70 (1987).

112 *See* J. Edward Graham, Jr. & William W. Hall, Jr., *Hurricanes, Housing Market Activity, and Coastal Real Estate Values*, 69 APPRAISAL J. 379, 385–86 (2001). Graham and Hall use different measures of market reaction (the spread between listing and selling price, average days on the market, and monthly sales), when looking at the same natural hazard realization—the series of hurricanes and storms that struck the Cape Fear Region of North Carolina ending in 1999. J. Edward Graham & William W. Hall, *Catastrophic Risk and Behavior of Residential Real Estate Market Participants*, 3 NAT. HAZARDS REV. 92, 96 (2002). This study's main result, that the spread between asking and selling prices increased by eight percent after the fourth and final hurricane strike, *id.*, also tends to support the earlier finding that this series of storms eventually caused people to revise upward their perceived probability of such storms.

Still, the risk of loss from hurricanes and similar severe storms is an expected cost to people who live in such storm prone places. But hurricanes and other coastal storms are the downside of living in coastal locations; for many people, despite this downside, living near the coast seems to be worth more and more. Since the 1960s, the coastal population in the United States has grown at more than double the national growth rate, and over the last fifty years, the value of coastal real estate has appreciated at an average of seven percent per year over the last fifty years, with waterfront property worth up to forty-five percent more than comparable inland property.[113] Even with an arguably vast expansion in popular knowledge about the risks of living in coastal areas, the market value of living on the coast has increased spectacularly. Indeed, recent empirical evidence shows while in mainland housing markets, location in a 100 or even 500 year floodplain lowers property values, for property on the Outer Banks of North Carolina (one of the most hurricane-prone areas in the United States), location within a 100 or 500 year floodplain actually increases property value.[114] Indeed, Outer Banks properties within the 100-year floodplain with wave exposure—which are ocean front properties (as opposed to properties facing Pamlico Sound)—command a 26.5% locational premium.[115]

That Americans have an increasingly high willingness to pay for coastal locations such as the Outer Banks is only part of the explanation for why they are willing to pay ever-higher prices for such scarce locations, despite their very high relative risk of loss from hurricanes and other storms. Another important reason for increasing coastal land values is that hurricanes and other natural disasters are simply becoming less dangerous to human life and therefore less likely to cause discounting of coastal properties.[116] Studying a relatively broad

113 *See* Okmyung Bin & Jamie Brown Kruse, *Real Estate Market Response to Coastal Flood Hazards*, 7 NAT. HAZARDS REV. 137, 137 (2006); *see also* Joseph J. Cordes & Anthony M.J. Yezer, *In Harm's Way: Does Federal Spending on Beach Enhancement and Protection Induce Excessive Development in Costal Areas?*, 74 LAND ECON. 128, 128 (1998) (finding that in the forty-two Atlantic and Gulf beachfront communities they sampled from the Maine-Texas coastline, the average annual rate of growth in housing units from 1960 to 1992 was 3.9%, a rate of growth more than 50% higher than the national growth rate of approximately 2.4%).

114 *See* Bin & Kruse, *supra* note 113, at 141. For another study finding that floodplain location lowers property values in inland areas (in this study, an area near Gainesville, Florida), see David M. Harrison et al., *Environmental Determinants of Housing Prices: The Impact of Flood Zone Status*, 21 J. REAL EST. RES. 3, 12 (2001).

115 Bin & Kruse, *supra* note 113, at 141.

116 Indeed, the list of natural hazard adaptation measures available to developed countries such as the United States includes at least the following:

set of natural disasters, Kahn found that the average number of deaths per disaster fell an average of 4.6% per year over the period 1970 to 2001.[117] Just as air conditioning reduced the discomfort from the South's warm and humid climate, stimulating labor productivity in and hence migration to the southern United States,[118] so too have advances in weather forecasting, communications, construction, and transportation infrastructure significantly decreased the cost, and hence increased the expected net value, from living in warm, humid, but storm-prone coastal locations.[119] Given both the increasing value

---

> [E]arly warning systems and large-scale evacuations; . . . disaster insurance; . . . reforestation, soil conservation, mangrove replantation, and other natural defenses; strengthen[ing of] docks, harbor facilities, and telecommunication and satellite systems; build[ing of] protective barriers for sea surges and water diversion channels; fortif[ication of] drainage, irrigation, water supply, and sanitation infrastructure; organiz[ation of] relocation efforts and "managed retreats"; smooth recovery for firms and sectors suffering serious losses; enforce[ment of] efficient zoning regulations; administ[ration of] public health and educational services; and . . . emergency treatment for victims.

J. TIMMONS ROBERTS & BRADLEY C. PARKS, A CLIMATE OF INJUSTICE 111 (2007).

117 Matthew E. Kahn, *Two Measures of Progress in Adapting to Climate Change*, 13 GLOBAL ENVTL. CHANGE 307, 309 (2003). Kahn's list of natural disasters included earthquakes, extremes of heat and cold, floods, and a broad "wind storm" category that included hurricanes, storms, tornadoes, tropical storms, typhoons, and winter storms. *Id.* at 308.

118 For evidence of adaptation to warmer climates, see Cragg & Kahn, *supra* note 87, at 534–35 (showing that while people's willingness to pay for a warm climate has increased over the period 1960 to 1990, southern earnings have not fallen (as would be expected from rising demand for warm climate, as people accepted lower earnings in order to live in warm climates)). The coincidence of both rising earnings and employment in the South is generally ascribed to the adoption of the air conditioner, a form of adaptation to hot and humid summers that had a remarkably large impact in increasing labor productivity. Walter Y. Oi, *The Welfare Implications of Invention*, *in* THE ECONOMICS OF NEW GOODS 109, 127–28 (Timothy F. Bresnahan & Robert J. Gordon eds., 1997) (recounting how air conditioning rates in the South rose from fifty-eight percent to ninety-one percent over the 1970 to 1990 period versus only from forty-four percent to seventy percent nationally).

119 Especially with federally subsidized coastal flood insurance programs, for the individual coastal property owner, the amount risked per dollar invested has almost surely fallen over the time period 1960 to 1990. How much of this decrease in individual loss exposure is due to subsidized insurance, versus adaptive construction standards, is difficult to determine. Note that there is no inconsistency between a reduction due to adaptation in an individual coastal property owner's risk of loss from floods and hurricanes and the increase in the total losses from hurricanes and other coastal storms so clearly documented by Roger A. Pielke, Jr. & Christopher W. Landsea, *Normalized Hurricane Damages in the United States: 1925–1995*, 13 WEATHER & FORECASTING 621, 630–31 (1998). Indeed, by lowering individual cost, programs like

and decreasing expected cost of living in coastal locations, were climate change to generate a net increase in the supply of such locations, then it might generate a very, very large increase in social welfare as measured by market prices. Hence, a crucial question for climate change research should be whether by warming the atmosphere and seas, global warming may generate a net increase of the supply of such risky but nonetheless highly desirable coastal locations.[120]

4. Global Warming Will Either Boost the U.S. Agricultural Sector or Have Minimal Effects

A relatively well-known benefit to the United States (and Canada will have an even bigger benefit of this sort) from global warming is a likely increase in agricultural productivity. This is recognized even by the IPCC, which grudgingly conceded that during the rapid warming that occurred during the period 1970 to 2000, corn yield in the U.S. Midwest increased twenty percent, and that warmer nights have "enhanced the production of high-quality wine grapes."[121] Unsurprisingly, the IPCC's discussion just hints at the possible benefits. A recent and comprehensive study of the impact of climate change on U.S. agriculture has found an increase in economic welfare of between $800 million and $7.8 billion in 2030 and between $3.2 and $12.2 billion in 2090, depending upon which of two models of climate change is used.[122] These welfare gains are driven by massive predicted increases in aggregate U.S. agricultural productivity, and although U.S. producers may suffer income losses (if market prices fall because U.S. productivity increases are not offset by declining production else-

---

federal disaster relief and federal flood insurance stimulate demand for coastal properties and increase the total developed value at risk in coastal areas.

120 Even taking as given the generally agreed-upon predictions that global warming will increase mean temperature, lessen seasonal swings, and increase storminess, it is possible that the answer to my question is "no," because increased temperature and lower seasonal variation does nothing to increase the supply of places with really beautiful beaches and the other characteristics that make the Outer Banks and similar coastal areas valuable. For an idea of the variety of value-determining characteristics, see Earl D. Benson et al., *Water Views and Residential Property Values*, 68 APPRAISAL J. 260, 269 (2000) (finding that enhanced views of water increase property value); James R. Rinehart & Jeffrey J. Pompe, *Adjusting the Market Value of Coastal Property for Beach Quality*, 62 APPRAISAL J. 604, 608 (1994) (finding that a wider beach increases property value).

121 INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, WORKING GROUP II, CLIMATE CHANGE 2007 624 (Martin Parry et al. eds., 2007) (internal citation omitted).

122 J. Reilly et al., *U.S. Agriculture and Climate Change: New Results*, 57 CLIMATIC CHANGE 43, 56 (2003).

where in the world), lower agricultural prices are predicted to make American consumers better off to the tune of between $2.5 and $13 billion in 2090.[123] Even more strikingly, under the widely used Hadley Center GCM, agricultural production is predicted to increase for all regions of the United States in both 2030 and 2090.[124] Finally, with agricultural production predicted to shift to regions that will not only be warmer but also much wetter, Reilly finds a very strong shift in comparative economic advantage away from irrigated cropping and toward dryland, and with a much smaller yield advantage to be gained from irrigation, they find that irrigation is no longer economically viable in many areas.[125] With many areas of the country historically drawing down groundwater supplies at unsustainable rates to supply the water demand of both agriculture and growing urban populations, the decrease in agricultural demand for groundwater predicted by Reilly is a significant potential environmental benefit.

The ability of farmers to adapt quickly to changing climate conditions is indeed a crucial factor in deriving U.S. agricultural benefits from global warming. The best way to empirically estimate how farmers will adapt to generally warmer conditions is by looking at how they have already adapted to the very large existing climatic variations in the United States. Such studies—which are based on real, cross-sectional data and estimate statistically the actual relationship between agricultural land prices, climatic, economic, and soil variables—essentially use the existing climate as a natural experiment in climate and agriculture. One study of this sort has found a relatively complex relationship between climate and agricultural value (as measured by land prices), with higher average temperatures in October and April

123 *Id.*

124 *See id.* at 57 fig.3. Under a different GCM of climate change run by Reilly and colleagues, the large predicted net aggregate gain in U.S. agricultural product results from very large gains in some regions (the Great Lakes states, the Corn Belt, the mountain states, and the Pacific Northwest) and quite severe declines in others (the Southeast and southern plains). *See id.* The difference between the two GCMs is not only in the temperatures they predict for different regions under increasing CO_2, but—and most importantly for agricultural production—in the amount of rainfall they predict. Although a warmer climate must on average have higher humidity, the Canadian Center GCM predicts that rainfall patterns will shift north and west, dramatically increasing the drought frequency in the southeastern and southern plains U.S. states. Although they do not acknowledge this until the conclusion to their paper, the Canadian Center GCM "produces relatively extreme high temperatures compared with other climate models whereas the Hadley Center model produces temperature increases closer to the middle of existing climate models, but it produces particularly high levels of precipitation increases for the U.S." *Id.* at 66.

125 *See id.* at 59.

clearly increasing farm value, higher temperatures in July and January reducing farm value, and higher precipitation increasing farm value only if it comes in January and April (versus July or October).[126] Moreover, this study finds that even in the United States, interannual climatic variation reduces farm values. Climate change is predicted to have clearly beneficial effects for increases of 2.5 degrees centigrade—with the amount of cropland increasing a little but crop revenue increasing significantly (between seventeen percent and twenty percent, depending upon how much additional rainfall comes with increased temperature)—but somewhat more ambiguous effects for a five degree centigrade increase—with cropland down somewhat, while crop revenue increases enormously (between twenty-six percent and twenty-eight percent).[127]

Another approach that has been used to estimate the impact of changing climate on U.S. agriculture is to examine how year-to-year fluctuations in temperature and precipitation have influenced agricultural profits.[128] Using state-level climate change projections from the Hadley 2 OAGCM, one such study finds that if climate warms by two to three degrees centigrade (with about three inches more rainfall on average), then aggregate U.S. agricultural profits will increase by a modest amount, with an increase of $1.3 billion in annual profits, implying (with a five percent discount rate) an increase in the present value of U.S. agricultural land rents of $26 billion.[129] Although not statistically significant, this analysis also suggests that there may be very large interstate differences in the effect of climate change on agricultural profits: given the Hadley 2 state-specific predictions, California is expected to suffer a loss of nearly fifteen percent in its annual agricultural profits, while all other states together are predicted to have in an increase in agricultural profits.[130]

To be sure, the hedonic or cross-sectional analysis of the impact of climate change on agriculture has recently been criticized by other economists who find a variety of reasons to believe that the impact of global warming on U.S. agriculture (and agriculture generally) will be

126 Robert Mendelsohn et al., *The Impact of Climate Variation on U.S. Agriculture*, *in* THE IMPACT OF CLIMATE CHANGE ON THE U.S. ECONOMY, *supra* note 107, at 55, 63, 67.

127 *Id.* at 70–71.

128 *See* Olivier Deschênes & Michael Greenstone, *The Economic Impacts of Climate Change: Evidence From Agricultural Output and Random Fluctuations in Weather*, 97 AM. ECON. REV. 354, 355, 381 (2007) (adopting this approach after finding that traditional hedonic regressions of farm value on climate variables are not especially robust to sample selection and to explanatory variable inclusion).

129 *Id.* at 380.

130 *Id.* at 377.

harmful. However, this critical work can itself be criticized on various grounds.[131] For example, increases in wine quality and the number of varieties that can be produced in certain regions of both the United States and Europe[132] and an increase in the productivity of northern European agriculture and forestry.[133] The evidence shows that wealthy developed countries such as the United States almost surely have agricultural benefits from a warmer global climate.[134]

131 Perhaps the most dedicated economist critic is the German economist Wolfram Schlenker. *See* Wolfram Schlenker et al., *Will U.S. Agriculture Really Benefit from Global Warming? Accounting for Irrigation in the Hedonic Approach*, 95 AM. ECON. REV. 395 (2005). Schlenker and his colleagues show that the hedonic climate gradient is different as between counties that rely on irrigation and those that do not (so-called dryland counties). *Id.* at 397–98. However, the significance of their results for predicting the impact of climate change depends upon their assumption that subsidized irrigation will not be provided on the same terms as today if and when global warming increases the demand for it in current dryland counties. *See id.* at 396–97. A more recent work uses a novel dataset that uses regression methods to interpolate daily summer maximum temperatures on 2.5 mile square grids and finds that yields for corn, soybeans, and cotton fall steeply when surface air temperatures exceed a threshold daily maximum. *See* Wolfram Schlenker & Michael Roberts, *Estimating the Impact of Climate Change on Crop Yields: The Importance of Nonlinear Temperature Effects* 10–12 (Nat'l Bureau of Econ. Research, Working Paper No. 13799, 2008), *available at* http://www.ssrn.com/abstract=1092849. This is an interesting result, but it is subject to the general criticism of regression interpolation techniques for surface air temperature made by Roger Pielke, Sr. and his colleagues. *See* Roger A. Pielke, Sr. et al., *Unresolved Issues with Assessment of Multidecadal Global Land Surface Temperature Trends*, J. GEOPHYSICAL RES., Dec. 2007, at D24S08, at 2–12; *see also* Schlenker & Roberts, *supra* at 10 fig.1 (depicting actual surface temperatures during the growing season and comparing this distribution to various future climate scenarios generated by the Hadley Center Coupled Ocean-Atmospheric GCM, ultimately revealing that the Hadley model predicts not a single-peaked, symmetric temperature distribution, but rather something quite different and very unusual).

132 *See* Gregory V. Jones et al., *Climate Change and Global Wine Quality*, 73 CLIMATIC CHANGE 319, 338–39 (2005). Somewhat differently, Orley Ashenfelter and Karl Storchmann take the hedonic approach one step further by estimating the impact of climate change on solar radiation and hence on the amount of solar radiant energy collected by vineyards in the Mosel region of Germany. Orley Ashenfelter & Karl Storchmann, *Using a Hedonic Model of Solar Radiation to Assess the Economic Effect of Climate Change: The Case of Mosel Valley Vineyards* 17–18 (Nat'l Bureau of Econ. Research, Working Paper No. 12380, 2006), *available at* http://www.ssrn.com/abstract=921546.

133 *See* Gianpiero Maracchi et al., *Impacts of Present and Future Climate Variability on Agriculture and Forestry in Temperate Regions: Europe*, 70 CLIMATIC CHANGE 117, 131–32 (2005).

134 *See* Robert Mendelsohn et al., *The Distributional Impact of Climate Change on Rich and Poor Countries*, 11 ENV'T. & DEV. ECON. 159, 173–74 (2006).

5. Global Warming May Increase the Frequency of Beneficial El Niño Events

Should global warming increase the frequency of El Niño events, then there will be a reduction in the frequency and severity of U.S. losses from hurricanes. In general, El Niño events generate positive net benefits for the United States as a whole. However, climate change models are unlikely ever to have the capability of predicting the impact of global warming on El Niño event frequency and severity. As neither of these points seems very well understood—neither the beneficial effects of El Niño events in the United States nor their inherent unpredictability—it is worth spending a bit of time to explain why.

The current set of GCMs is not very good at all in predicting the impact of global warming on El Niño frequency and intensity.[135] While several GCMs do indeed predict warming sea-surface temperatures (SST) in the equatorial eastern Pacific, this is not El Niño warming but a relatively simple and direct consequence of higher CO_2, and according to climate scientists, there is "still an open question" as to whether such increases in average SSTs due to CO_2 buildup will cause changes in El Niño Southern Oscillation (ENSO) amplitude, whether the changes in averages are statistically independent of ENSO, or whether they are just a "nonlinear residual."[136] As for ENSO frequency, GCMs are all over the map: in a run of twenty-one such models, eight predicted much shorter ENSO cycles than observed, five much longer cycles, with only eight of twenty-one doing a "relatively good" job at predicting ENSO oscillations.[137] Most seriously and quite intuitively, among the biases in GCMs (which are "as big as the signal

135 *See* Michael J. McPhaden et al., *ENSO As an Integrating Concept in Earth Science*, 314 SCIENCE 1740, 1744 (2006). As McPhaden and colleagues explain, while the "consensus outlook from the current generation of global climate models suggests no significant change in ENSO characteristics under various greenhouse gas emission scenarios that presume a doubling of atmospheric CO_2 from preindustrial levels over the next 100 years," ultimately, however, because "climate models have known flaws that compromise the reliability of future projections in the tropical Pacific . . . . [W]e cannot say with confidence at present how global warming will affect either ENSO variability or the background state on which it is superimposed." *Id.*

136 *See* Sang-Wook Yeh & Ben P. Kirtman, *ENSO Amplitude Changes Due to Climate Change Projections in Different Coupled Models*, 20 J. CLIMATE 203, 207 (2007) (hypothesizing that disagreement among the climate models in predicting ENSO amplitude is caused by varying degrees of nonlinearity in the models).

137 Jia-Lin Lin, *Interdecadal Variability of ENSO in 21 IPCC AR4 Coupled GCMs*, GEOPHYSICAL RES. LETTERS, June 2007, at L12702, at 2.

one is trying to predict"[138]) is a tendency to systematically underestimate tropical Pacific SSTs and hence to overpredict weakened easterly winds and—as such wind anomalies are precisely the condition that immediately precedes El Niño events—to overpredict the frequency of El Niño events.[139]

Still, suppose that the climate models that predict an increase in El Niño frequency due to global warming actually turn out to be correct: would this be a bad thing for the United States? The answer is almost surely "no." To see why this is so, it is important to briefly describe El Niño and the ENSO cycle of which it is a part. ENSO is a cycle between unusually warm (El Niño) and unusually cold (La Niña) sea surface temperatures in the tropical Pacific.[140] Under normal conditions, the easterly trade winds in the tropical Pacific cause the accumulation of warm surface water in the western Pacific and a corresponding upwelling of cold water in the equatorial eastern Pacific and coastal South America. Additionally, the sea surface west-east temperature gradient positively reinforces the east-west air pressure difference that drives the trade winds.[141] An El Niño event occurs when the easterly trades weaken (as atmospheric pressure rises in the western tropical Pacific and falls in the eastern Pacific) leading to warmer waters and less upwelling in the central and eastern Pacific, a change in sea surface temperatures that itself then feeds back on the air pressure gradient, and a further weakening of the trade winds that enhances the eastern and central Pacific sea surface warming even further.

Because SSTs in the tropical Pacific are directly related to changes in the Southern Oscillation—a major atmospheric pressure pattern—ENSO "is unique among climate phenomena in its strength, predictability, and global influence, projecting beyond the tropic Pacific through atmospheric teleconnections that affect patterns of weather variability worldwide."[142] A strong El Niño, for example,

138 Hilary Spencer et al., *El Niño in a Coupled Climate Model: Sensitivity to Changes in Mean State Induced by Heat Flux and Wind Stress Corrections*, 20 J. CLIMATE 2273, 2273 (2007).

139 *See id.* at 2295.

140 This and the remainder of my description of the ENSO phenomenon is drawn from McPhaden et al., *supra* note 135, at 1740.

141 *Id.*

142 *Id.* For a detailed discussion of how tropical ENSO events influence weather at much higher latitudes (ENSO teleconnections), see Kevin E. Trenberth et al., *Progress During TOGA in Understanding and Modeling Global Teleconnections Associated with Tropical Sea Surface Temperatures*, J. GEOPHYSICAL RES., June 1998, at 14,291. Interestingly, it has recently been found that the global impact of both warm (El Niño) and cold (La Niña) phases of ENSO is strongly dependent upon the level of solar activity, with

brings drought to Australia, Indonesia, and other parts of the western Pacific while inundating islands in the central Pacific and the west coast of South America in torrential rain.[143] Although the impacts of strong El Niño and La Niña events at higher latitudes and in oceans other than the Pacific are more attenuated and therefore less predictable, it is known that Atlantic hurricanes "tend to be reduced in number and intensity during moderate-to-strong El Niño events but stronger and more numerous during La Niña events," and that "[t]hese year-to-year changes translate into a 3-to-1 greater likelihood of a major Atlantic hurricane striking the United States during La Niña versus El Niño years, with correspondingly higher losses during La Niña years."[144]

El Niño events are currently (and may be inherently) unpredictable in advance of the weakening of trade winds that bring them on.[145] However unpredictable in advance they may be, as one leading

---

ENSO having a noticeable impact on the whole lower stratosphere and upper tropical troposphere—affecting both the subtropical jet stream and the polar vortex—only during solar minima. *See* Vladimir N. Kryjov & Chung-Kyu Park, *Solar Modulation of the El-Niño/Southern Oscillation Impact on the Northern Hemisphere Annular Mode*, GEOPHYSICAL RES. LETTERS, May 2007, at L10701, at 3.

143 McPhaden et al., *supra* note 135, at 1741 (noting that weaker events such as the El Niño of 2004 to 2005 "may have impacts that are muted or even undetectable above the background weather noise of the atmosphere").

144 *Id.* The larger vertical shear that accompanies an El Niño has its greatest effect on storm patterns in the area between ten degrees and twenty degrees North from North Africa to Central America. Roger A. Pielke, Jr. & Christopher N. Landsea, *La Niña, El Niño, and Atlantic Hurricane Damages in the United States*, 80 BULLETIN AM. METEOROLOGICAL SOC'Y. 2027, 2028 (1999). Hence the larger vertical shear associated with El Niño tends to reduce the number of Atlantic tropical storms. *Id.* at 2028. When Pielke and Landsea looked at normalized hurricane damages over the period 1925 to 1997 (damages indexed to take account of inflation, wealth, and population), they found a large difference in the probability of hurricanes generating more than $1 billion in damages between El Niño versus La Niña or neutral years, with a 0.77 probability in La Niña years and 0.48 probability in neutral years versus only a 0.32 probability in El Niño years. *Id.* at 2029–31. It is true that Pielke and Landsea found that the frequency of very damaging hurricanes, with losses exceeding $5 billion, did not vary as much between La Niña and El Niño years, but there were relatively few such storms even over their long sample period; for this reason they found no statistically significant difference in the probability of such very large storms in La Niña versus El Niño years. *Id.* at 2031.

145 There are actually now two different theories of the Southern Oscillation of which El Niño is a component: the first holds that it is a "weakly dampled oscillator that needs to be triggered by a random disturbance. Westerly wind bursts in the western equatorial Pacific appear necessary [on this theory] at the onset of El Niño"; the second theory views the "Southern Oscillation . . . as a lower frequency self-sustaining mode of oscillation in the tropical Pacific." David J. Stephens et al., *Differences in Atmospheric Circulation Between the Development of Weak and Strong Warm Events in the*

meteorologist has recently commented, "all weather conditions produce winners and losers, and in general, less is known about the winners than about the losers."[146] This is perhaps especially true of ENSO, as "it is often the adverse impacts of ENSO variations that receive the most publicity, whereas the benefits, at least for some regions of the globe, are much less understood and appreciated."[147] For example, although the strong 1997 to 1998 El Niño brought devastating drought and fire to areas of the western Pacific and Central America, it generated both costs and benefits for the United States. As predicted, the 1997 to 1998 El Niño brought coastal storms and heavy rains to California and an increased number of severe rainstorms (and accompanying tornadoes) to Florida, Texas, and other southern states.[148] By the end of May, 1998, 189 deaths nationally had been attributed to the El Niño conditions.[149]

Yet the 1997 to 1998 El Niño also generated clear benefits for the United States. The mild, virtually snow-free winter it caused in the northern United States was estimated to have reduced by 828 the number of deaths due to extreme low temperatures and to snow and ice storms, and to have saved almost $14 billion in reduced heating costs and losses due to spring snowmelt floods.[150] By eliminating major Atlantic hurricanes, the 1997 to 1998 El Niño not only elimi-

Southern Oscillation, 20 J. CLIMATE 2191, 2192 (2007). On the latter theory, the quasi-periodicity of the ENSO cycle is understood as an aspect of a natural oscillator in the tropical Pacific coupled ocean-atmosphere system. *See* Nicholas E. Graham & Warren B. White, *The El Niño Cycle: A Natural Oscillator of the Pacific Ocean-Atmosphere System*, 240 SCIENCE 1293, 1293–97 (1988); Eli Tziperman et al., *El Niño Chaos: Overlapping of Resonances Between the Seasonal Cycle and the Pacific Ocean-Atmosphere Oscillator*, 264 SCIENCE 72, 73 (1994). This oscillator is a low order, nonlinear chaotic system, and hence somewhat predictable in the short-term. *See* José A. Rial et al., *Nonlinearities, Feedbacks and Critical Thresholds Within the Earth's Climate System*, 65 CLIMATIC CHANGE 11, 26 (2004). This is not the only view, however, and not a view toward which recent evidence has been especially kind. As McPhaden and his contributors explain, optimism of the 1980s regarding the possibility of developing models that would allow the prediction of ENSO up to a year in advance faded during the 1990s, as existing models failed to "predict the onset, rapid growth, ultimate magnitude and sudden demise of the giant 1997 to 1998 El Niño" and failed also to reliably predict the "weak to moderate strength ENSO related fluctuations of the early to mid-1990s." McPhaden et al., *supra* note 135, at 1742. Most recently, the El Niño of 2006 to 2007 was not recognized until large wind shifts were observed in the western Pacific in July of 2006. *Id.*

146 Stanley A. Changnon, *Impacts of 1997–98 El Niño Generated Weather in the United States*, 80 BULL. AM. METEOROLOGICAL SOC'Y, 1819, 1826 (1999).

147 McPhaden et al., *supra* note 135, at 1743.

148 Changnon, *supra* note 146, at 1819, 1821.

149 *Id.* at 1821.

150 *Id.* at 1821, 1825.

nated the $5 billion in property damage that hurricanes had been causing on average in the United States during the 1990s, but also saved an expected twenty lives that would have been lost in hurricanes.[151] On balance, the 1997 to 1998 El Niño was estimated to have generated net economic gains to the United States of $8 to $22 billion and to have saved 661 lives.[152]

6. Summary: The Benefits to the United States from Global Warming

The long list of potential benefits to many regions of the United States from global warming just recounted is not meant to suggest that global warming will benefit all regions of the planet Earth. My focus in this Article is relatively narrow: to inquire whether it is reasonable to interpret the CAA—a statute designed to provide the benefit of reduced local air pollution harms to virtually every developed metropolitan region of the United States—to also mandate a reduction in U.S. GHG emissions because those emissions are believed to contribute to global warming? The long list of short-to medium-term benefits to many regions of the United States from moderate global warming must, I believe, be a key part of the answer: it is hard to imagine that the Congress which passed the CAA to reduce harm from air pollution would also have wanted to mandate costly reductions in gases whose short-to medium-term impact on the United States would not to cause harm, but confer benefits.

D. Availability, Effectiveness, and Distribution of the Costs of Alternative Approaches to Reducing GHG Emissions

To decide that Congress would have wanted EPA to regulate GHGs under the CAA, a judge must also consider the feasibility and cost of such regulation. Not only does the CAA require costs to be considered in the setting of automobile emission standards,[153] but the structure of the CAA was also fundamentally changed in both 1977 and 1990—largely as a result of Congress' learning about and concern

151 *Id.* at 1823.

152 *Id.* at 1826 tbl.1.

153 Under section 202(a)(3)(A)(i), emission standards for hydrocarbons, carbon monoxide, oxides of nitrogen, and particulate matter for engines made after 1983 "shall contain standards which reflect the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the model year to which such standards apply, giving appropriate consideration to cost, energy, and safety factors associated with the application of such technology." 42 U.S.C. § 7521(a)(3)(A)(i) (2000).

with the regional distribution of the costs of air pollution reduction.[154] When it comes to the goal of reducing GHG emissions from automobiles, the basic structure of the CAA simply does not give EPA the authority to pursue the range of policies needed to achieve the goal. A more general program of reducing GHG emissions from power plants and other sources—as the Court's decision in *Massachusetts v. EPA* almost surely requires—likewise entails new and as yet unavailable technologies and a potentially massive national redistribution of costs and benefits of control. The complex bargain among different regions and different industries that is the CAA in no way can be extended to include GHG emission control. In particular, the likely concentration of the costs of reducing GHG emissions on the shoulders of poor, rural households is so unfair as to make it very unlikely that any Congress—either the current Congress or the one that wrote the CAA—would vote in favor of such a program of emission reduction unless some kind of benefits—far beyond the mere reduction in U.S. GHG emissions—were extended to the people and states who would be bearing most of the costs of GHG emission reduction.

1. Reducing Automobile GHG Emissions: Policy Responses Are Costly and Congress Has Pursued Them in Separate Legislation, Not in the CAA

In *Massachusetts v. EPA*, the Court did not of course resolve the question of which particular policy instruments should be chosen by EPA as a way of reducing GHG emissions from cars. When it comes to greenhouse gas emissions from autos, EPA's primary statutory policy instrument for reducing conventional air pollutants in automobile emissions—emission standards based on technologies such as catalytic converters—is completely ineffective.[155] This is true for the simple but fundamental reason that CO_2, the most significant human-produced GHG, is an inherent byproduct of combustion of carbon-based fuels.

The only ways to reduce the amount of CO_2 in auto emissions are to reduce the amount of fuel used by autos—to mandate improvements in fuel efficiency—or to mandate a change in the composition of the fuel by requiring the use of fuels with lower carbon content and/or lower net carbon emissions through their full life cycle (pro-

154 *See* BAILEY, *supra* note 50, at 188–99, 227–37.

155 *See* Richard O. Faulk & John S. Gray, Stormy Weather Ahead? The Legal Environment of Global Climate Change 60–61 (2007) (unpublished manuscript, on file with author), *available at* http://works.bepress.com/richard_faulk/2/.

duction to combustion in cars).[156] Although Congress has in fact recently increased auto fuel economy standards,[157] such fuel economy standards are not set by EPA, but rather by the Department of Energy.[158] Congress has also mandated the use and subsidized the production of ethanol as an alternative fuel that may have the potential to be a cleaner fuel—in terms of total CO_2 emissions—than gasoline.[159] Once again, however, Congress has mandated biofuel use in separate energy legislation that has nothing to do with EPA.[160] Another alternative path to reducing the amount of gasoline burned and CO_2 emitted is to subsidize consumer purchases of high mileage and hybrid gas-electric vehicles. In the Energy Policy Act of 2005,[161] Congress provided such subsidies to purchasers of hybrids—in the

156 *See* Press Release, European Union, Questions and Answers on the EU Strategy to Reduce CO_2 Emissions from Cars 1, 4 (July 2, 2007), *available at* http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/07/46.

157 For a discussion of the new Corporate Average Fuel Economy (CAFE) standards found in the Energy Independence and Security Act of 2007, Pub. L. No. 110-140, 121 Stat. 1492, see *infra* notes 158–163.

158 The Department of Energy acts in this way under the authority of the Energy Policy and Conservation Act as amended by the Energy Independent and Security Act. Energy Policy and Conservation Act § 1(e), 49 U.S.C.A. § 32902 (West 2007), *amended by* Energy Independence and Security Act of 2007, Pub. L. No. 110-140, § 102, 121 Stat. 1492, 1498–1501 (codified at 49 U.S.C.A. § 32902 (West Supp. 2008)).

159 *See* Faulk & Gray, *supra* note 155, at 63 (discussing the renewable fuel standard program created by the Energy Policy Act). As I discuss below, *infra* notes 160–163, the ethanol requirement has been massively increased by the Energy Independence and Security Act of 2007. The corn-based ethanol currently being subsidized and used in the United States to the tune of over 250,000 barrels per day is a net source of CO_2, and the federal government is currently funding research into cellulosic ethanol, which has the potential to be a carbon negative fuel. *See* Katharine Sanderson, *A Field in Ferment*, 444 NATURE 673, 673 (2006) (explaining the challenges surrounding the development of ethanol). Recent work strongly suggests that this potential is very unlikely to be realized, because when account is taken of the lost carbon sequestration due to the conversion of forests and grasslands to biofuel crop production, moving to ethanol as a fuel involves massive net increases in CO_2: as much as fifty percent if the fuel is switchgrass and between 17 and 420 times current CO_2 emissions if the fuel is corn or sugarcane. *See* Joseph Fargione et al., *Land Clearing and the Biofuel Carbon Debt*, 319 SCIENCE 1235, 1235 (2008); Timothy Searchinger et al., *Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land Use Change*, 319 SCIENCE 1238, 1238 (2008).

160 In the Energy Policy Act of 2005, Congress tripled the ethanol requirement in automobile fuel, § 1501, 42 U.S.C.A. § 7545 (West Supp. 2008), and in the Energy Independence and Security Act of 2007 Congress increased the ethanol requirement even further, quadrupling ethanol requirements over the 2009 to 2022 period, § 202, 42 U.S.C.A. § 7545 (West Supp. 2008).

161 Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594.

form of a tax credit worth up to $3400 during early 2006.[162] The effectiveness of these policies depends in large part upon consumer behavior in choosing what car to drive and how much to drive it.[163] Still, Congress has implemented tax incentives for hybrids not in the CAA, but in energy legislation.

There are still other policy options. For example, from an environmental point of view it would be far better if, instead of mandating the use of biofuels, Congress used the revenue from a gasoline tax to conserve and even expand the range of existing forests and savannahs.[164]

All of these different policy instruments for reducing automobile GHG emissions carry costs. Increasing Corporate Average Fuel Economy (CAFE) standards, for example, has a substantial welfare cost, because improvements in fuel efficiency lead to an increased number of miles driven by motorists. The increase in miles driven has large external costs—from increased congestion, accidents, and local pollution—that have been recently estimated at $2.45 per gallon for a four mile per gallon increase in fuel economy.[165] These externalities are so large that such an increase in fuel efficiency would generate a large welfare loss notwithstanding reasonable estimates of the combined reduction in the external costs of oil dependence, carbon emissions, and local upstream emissions.[166] Reducing GHG tailpipe emissions by increasing automobile efficiency may generate savings to automobile drivers by reducing fuel bills. But such fuel efficiencies are expensive to achieve and so will entail significantly higher prices for cars. Poor consumers may be unable to afford such new, pricey vehicles, and may therefore face the prospect of being priced out of the market for auto-

162 *See* Energy Policy Act § 1341(a), 26 U.S.C. § 30B (2006); *see also* James M. Sallee, The Incidence of Tax Credits for Hybrid Vehicles 2 (Jan. 22, 2008) (unpublished manuscript, on file with author). Thirteen states have legislated tax incentives for hybrids. *See* Union of Concerned Scientists, State and Federal Hybrid Incentives, http://go.ucsusa.org/hybridcenter/incentives.cfm (list visited Oct. 2, 2008).

163 *See* BRENT D. YACOBUCCI & ROBERT BAMBERGER, CONG. RESEARCH SERV., AUTOMOBILE AND LIGHT TRUCK FUEL ECONOMY 3–5 (2008), *available at* http://ncseonline.org/nle/crsreports/06nov/rl33413.pdf; B.B. Gleisner & S.A. Weaver, *Cars, Carbon and Kyoto*, 1 KOTUITUI: N.Z. J. SOC. SCIS. ONLINE 81, 85 (2006), *available at* http://www.royalsociety.org.nz/site/publish/journals/kotuitui/2006/06.aspx.

164 *See* Renton Righelato & Dominick V. Spracklen, *Carbon Mitigation by Biofuels or by Saving and Restoring Forests?*, 317 SCIENCE 902, 902 (2007).

165 Carolyn Fischer et al., *Should Automobile Fuel Economy Standards Be Tightened?*, ENERGY J., 4th Quarter 2007, at 1, 19–20.

166 *Id.*

mobiles.[167] In the United States (unlike much of Europe), the consequences of being priced out of the automobile market are often grim: a poor American who is unable to afford a car faces a severe restriction in educational and employment opportunities.[168]

Moreover, the cost of reducing automobile GHG emissions is likely to vary across different American states and regions. For example, increases in gasoline taxes are generally regressive, hurting the poor more than the rich (because gasoline expenditures generally account for a lower share of a wealthier person's income).[169] Higher gasoline taxes also generally cost people who live in rural areas more than they cost people who live in urban areas (because people in rural areas drive more).[170]

Ignoring any transfer payments that might be made, the direct and indirect impacts of an economy-wide cap and trade program for CO_2 emissions would also likely be severely regressive. Dallas Burtraw and colleagues have estimated that in a benchmark case with an equilibrium price of CO_2 of $41.50 per ton, a cap and trade program would increase expenditures in the middle-income decile by about two percent, while for the lowest income decile, the expenditures would increase by over four percent. In terms of overall welfare impacts, the impact on the poorest decile would be even greater, amounting to a ten percent decrease in welfare.[171]

With these large, potentially regressive, and unequally geographically distributed costs of alternative policies for reducing automobile emissions, it is hardly surprising that Congress has dealt warily and cautiously in implementing these policies. Most importantly, virtually all of the policy instruments for directly or indirectly reducing automobile emissions—from biofuels requirements to CAFE standards—are not found in the CAA, but in other statutes, and EPA is not the agency implementing them. Indeed, of all the potential policy instru-

167 *See* Michael P. Vandenbergh & Brooke Ackerly, *Climate Change: The Equity Problem*, 26 VA. ENVTL. L.J. 53, 61–62 & n.20 (2008) (citing CONG. BUDGET OFFICE, TRADE-OFFS IN ALLOCATING ALLOWANCES FOR CO_2 EMISSIONS 3 (2007), *available at* http://www.cbo.gov/ftpdocs/89xx/doc8946/04-25-Cap_Trade.pdf).

168 *See* Matthew A. Dombroski, Note, *Securing Access to Transportation for the Urban Poor*, 105 COLUM. L. REV. 503, 505–11 (2005).

169 CONG. BUDGET OFFICE, REDUCING GASOLINE CONSUMPTION 29–30 (2002), *available at* http://www.cbo.gov/ftpdocs/39xx/doc3991/11-21-gasolinestudy.pdf. Somewhat surprisingly, there is apparently no formal work on the distributional impact of CAFE standards. *See id.* at 29.

170 *Id.* at 32.

171 Dallas Burtraw et al., *The Incidence of U.S. Climate Policy, Where You Stand Depends on Where You Sit* 27–30 (Res. for the Future Discussion Paper 08-28, 2008), *available at* http://ssrn.com/abstract=1272667.

ments for reducing GHG emissions in automobile exhausts, the only one that EPA has authority to adopt under the CAA is to require a change in the composition of automobile fuel.[172] One must ask whether a Congress that intended for EPA to regulate GHG emissions from automobiles would have so severely limited the regulatory tools available to the agency to accomplish this goal.

2. Cost Distribution Issues in Reducing GHG Emissions from Non-auto Sources

As other legal scholars have clearly explained, the Court's broad reading of "pollutant" under the CAA will have the effect of compelling EPA to regulate not only automobile tailpipe GHG emissions, but also GHG emissions from stationary sources—directly for new stationary sources (which must comply with federal new source emission standards) and indirectly, through NAAQS, for existing stationary sources.[173] Issues regarding the magnitude and distribution of cost of reducing GHG emissions from automobile tailpipe emissions are just as severe when it comes to policies to reduce GHG emissions from stationary sources.

As for the distribution of emission reduction cost across income levels, studies indicate that the distribution of the cost of reducing GHG emissions from stationary sources may be just as regressive as is the cost of reducing automobile tailpipe GHG emissions. The only currently available method of reducing CO_2 emissions from coal-burn-

172 Under section 211 of the CAA, EPA has the authority to regulate automobile fuel and fuel additives. 42 U.S.C. § 7418 (2000). Under draft legislation introduced in the U.S. House of Representatives in June, 2007, EPA would be given the express authority to regulate the carbon content of automobile fuels. *See* STAFF OF H.R. SUBCOMM. ON ENERGY AND AIR QUALITY, 110TH CONG., ALTERNATIVE FUELS, INFRASTRUCTURE AND VEHICLES (Discussion Draft 2007), *available at* http://energycommerce.house.gov/energy_110/Title%20I%20-%20Fuels%20060107_xml.pdf.

173 *See* Jonathan H. Adler, Massachusetts v. EPA *Heats Up Climate Policy No Less Than Administrative Law: A Comment on Professors Watts and Wildermuth*, 102 NW. U. L. REV. COLLOQUY 32, 37–39 (2007) ("Whatever impact *Massachusetts v. EPA* has on administrative law, one thing is certain: Barring congressional intervention, this decision will cause the EPA to regulate the emission of greenhouse gases from new motor vehicles, as well as from other sources . . . . Once the EPA makes the required finding under section 202 [the automobile tailpipe provision], it will be child's play to force greenhouse gas emission regulation under other Clean Air Act provisions."); Faulk & Gray, *supra* note 155, at 66–74. For the same conclusion, but from the perspective of the plaintiffs in *Massachusetts v. EPA*, see Heinzerling, *supra* note 32, at 5 ("[T]he legal reasoning behind EPA's decision not to control greenhouse gas emissions in setting New Source Performance Standards for power plants has been upended by the Court's decision.").

ing power plants increases a typical customer's utility bills by forty-four percent.[174] Given that poor households are well known to spend disproportionately more on energy than wealthier households,[175] unless offsetting measures are taken, the cost of reducing GHG emissions from power plants will clearly fall disproportionately on the poor.[176] And not just the poor, but especially poor minorities may disproportionately bear the burden of reducing GHG emissions. In opposing the Kyoto Protocol, a study commissioned by minority organizations

174 Eli Kintisch, *Making Dirty Coal Plants Cleaner*, 317 SCIENCE 184, 186 (2007). This method involves passing treated flue gas through an absorber with the solvent monoethanolamine (MEA); the solvent bonds with CO_2 molecules, the CO_2/MEA complexes are then separated out, and, finally, the CO_2 is purified for ground storage. *Id.* at 185. A model Energy Department–sponsored plant called Future Gen that uses a newer and more advanced technique, integrated coal gasification, has greatly increased in cost (from $1 to $1.8 billion) and the Energy Department is now requiring private utilities to bear a greater share of the cost of the project. *See* Andrew C. Revkin, *A 'Bold' Step to Capture an Elusive Gas Falters*, N.Y. TIMES, Feb. 3, 2008, § 4, at 4.

175 *See* JAMES P. STUCKER, THE IMPACT OF ENERGY PRICE INCREASES ON HOUSEHOLDS: AN ILLUSTRATION 18 (Rand Paper Series No. P-5585, 1976) ("Direct energy expenditures are usually regressive in their structure, lower income households spend a greater portion of their consumption budget (and their income) on energy purchases than wealthier families . . . all of the obvious types of energy taxes are probably regressive; utility gas taxes are probably the most regressive, and taxes on refined petroleum products—including gasoline—the least."). More recently, Ian W.H. Parry estimates that the poorest fifth of households spend almost 10% of its income on electricity, while the richest fifth spend less than 6% of its income on electricity. Ian W.H. Parry, *Are Emission Permits Regressive?*, 47 J. ENVTL ECON. & MGMT. 364, 373 tbl.1 (2004). More dramatically, Jayanta Bhattacharya and colleagues find that while poor families increased their fuel expenditures and decreased their food expenditures during unusually cold months, richer families increased fuel expenditures, but did not decrease their food expenditures during such periods. Jayanta Bhattacharya et al., *Heat or Eat? Cold-Weather Shocks and Nutrition in Poor American Families*, 93 AM. J. PUB. HEALTH 1149, 1151 (2003).

176 A variety of ways to offset the impact on the poor of energy cost increases caused by GHG emission reduction measures have been surveyed. *See* ROBERT GREENSTEIN ET AL., CTR. ON BUDGET & POLICY PRIORITIES, DESIGNING CLIMATE-CHANGE LEGISLATION THAT SHIELDS LOW-INCOME HOUSEHOLDS FROM INCREASED POVERTY AND HARDSHIP 12–18 (2008), http://www.cbpp.org/10-25-07climate.pdf. Distributional considerations can dramatically alter the choice among closely related policy instruments. For example, Ian W.H. Parry finds that grandfathered CO_2 permits can be highly regressive, making the top fifth of income earners better off but the bottom fifth much worse off, *see* Parry *supra* note 175, at 367–70, 377–82, while in an earlier study, Terry M. Dinan & Diane Lim Rogers estimated that if CO_2 permits were instead auctioned off to utilities and then revenues returned in lump-sum rebates to all households, low-income households would be moderately better off while high-income households would be worse off by approximately $1700, Terry M. Dinan & Diane Lim Rogers, *Distributional Effects of Carbon Allowance Trading: How Government Decisions Determine Winners and Losers*, 55 NAT'L TAX J. 199, 213, 219 (2002).

such as the National Black Chamber of Commerce and Latin American Management Association found that Kyoto could cause "'1.4 million blacks and Hispanics to become unemployed, cause four million blacks and Hispanics to become impoverished, and reduce by ten percent the incomes of some twenty-five million black and Hispanic workers.'"[177]

The cost of GHG emission reduction is not only likely to be unequally distributed across rich and poor. Large interstate variations in the likely cost of complying with a federal regulation requiring power plants to reduce their GHG emissions are reflected in Figure 1. That figure shows how state per capita CO_2 emissions (measured in metric tons) range from lows of 11 in many Pacific coast and New England and northeastern states to 63 in West Virginia, 80 in North Dakota, and 125 in Wyoming. That state per capita CO_2 emissions are driven in large part by the predominant electric power fuel in a state is clearly revealed by a recent study, the Environmental Integrity Project. That study shows that power plants contributing the most CO_2 emissions are primarily (almost exclusively) coal-burning and are concentrated in twelve states: Texas, Pennsylvania, Indiana, Alabama, Georgia, North Carolina, Ohio, West Virginia, Wyoming, Florida, Kentucky, and New Mexico (ranked by total emissions).[178] Even within coal-burning states, there are variations in GHG emissions that reflect primarily the age and efficiency of the power plants and also the type of coal burned.[179]

Fuel source is not the only determinant of state CO_2 emissions. That states such as North Dakota and Wyoming have such high per capita CO_2 emission levels is not only due to their reliance upon coal as the source of energy to generate electric power, but also their location. Studies show, for example, that large, cold countries—places where people have to heat their homes and offices for many months of the year, and where even "local" travel typically involves long

177 See Faulk & Gray, *supra* note 155, at 48 (quoting Bruce Yandle & Stuart Buck, *Bootleggers, Baptists and the Global Warming Battle*, 26 HARV. ENVTL. L. REV. 177, 202 (2002)).

178 *See* Envtl. Integrity Project, Dirty Kilowatts: America's Most Polluting Power Plants 4–7 (July 2007) (unpublished manuscript), *available at* http://www.dirtykilowatts.org/dirty_kilowatts2007.pdf.

179 *Id.*

FIGURE 1[180]

PER CAPITA CO_2 BY STATE 2005

distances—systematically have higher per capita CO_2 emissions.[181] Fundamental differences in primary power plant energy source, population density, climate, and size have led to large and enduring differences in CO_2 emissions across different U.S. regions.

E. Implication: The Regional and Socioeconomic Distribution of Costs and Benefits from Reducing GHG Emissions Is So Radically Different From the Pattern of Costs and Benefits from Reducing Conventional Air Pollutants That the CAA Cannot Reasonably Be Interpreted to Mandate GHG Emission Reduction

By detailing how global warming is likely to actually benefit many regions of the United States in the short-to-medium term while GHG emission reduction will likely entail significant costs to many regions and to many poor people in the United States, my discussion thus far may well have made the reader wonder why Massachusetts or any other state would have been among the plaintiffs in a suit like *Massachusetts v. EPA*. There were in fact twelve state plaintiffs in that case:

180 *See* Energy Info. Admin., U.S. Dep't of Energy, Total CO_2 Emissions by State (2005), http://www.eia.doe.gov/oiaf/1605/ggrpt/excel/tbl_statetotal.xls; U.S. Census Bureau, Annual Estimates of the Population for the United States, Regions, States, and Puerto Rico: April 1, 2000 to July 2007 (2007), http://www.census.gov/popest/states/NST-ann-est.html.

181 *See* Eric Neumayer, *National Carbon Dioxide Emissions: Geography Matters*, 36 AREA 33, 36 (2004).

California, Connecticut, Illinois, Maine, Massachusetts, New Jersey, New Mexico, New York, Oregon, Rhode Island, Vermont, and Washington.[182] My discussion thus far has already revealed a major characteristic that all of these states have in common and a major reason that they sued EPA to compel GHG emission regulation: with the exception of New Mexico, all of these states already have relatively low per capita CO_2 emissions[183] and therefore stand to gain an economic comparative advantage relative to other, higher emitting states from federal regulation of GHGs. Given the relatively low costs and potential economic gain to the plaintiff states from federal GHG regulation, the attorneys general who actually represented the plaintiff states clearly felt no great need to find additional tangible benefits to justify a lawsuit that for them personally probably held the potential for very real political benefits.[184] To satisfy standing requirements, however, Massachusetts alleged, of course, that it would benefit from federal regulation of GHGs today because it would suffer harm from possible twenty-first century sea level rise due to global warming. The *Massachusetts v. EPA* majority was persuaded by Massachusetts' affidavit evidence, declaring that "'rising seas have already begun to swallow Massachusetts' coastal land,'"[185] and "[i]f sea levels continue to rise as predicted, one Massachusetts official believes that a significant fraction of coastal property will be 'either permanently lost through inundation or temporarily lost through periodic storm surge and flooding.'"[186] The other plaintiff states could have also pointed to evidence of similar potential harms to them and/or their citizens from global warming. For example, some climate models predict that New Mexico (and other southwestern states) will become more drought prone due to global warming;[187] as already discussed, the ski

182 Massachusetts v. EPA, 127 S. Ct. 1438, 1444–45 (2007).

183 *See supra* note 178 and accompanying text.

184 As Barry Rabe has persuasively argued, the fact that so many states and localities led U.S. efforts to pass GHG legislation is in large part to be explained by the desire of state and local politicians (what he calls "policy entrepreneurs") to advance their own careers by acquiring reputations as global warming policy leaders. BARRY G. RABE, GREENHOUSE & STATEHOUSE 23–29 (2004).

185 *EPA*, 127 S. Ct. at 1455–56 (quoting declaration of Paul H. Kirshen ¶ 5).

186 *Id.* (quoting declaration of Karst R. Hoogeboom ¶ 6).

187 Since, as explained above, the GCMs are indeed unable to predict how global warming is likely to affect the frequency and severity of ENSO, *see supra* note 137 and accompanying text, and since ENSO is a major determinant of large-scale weather patterns in regions such as the southwestern United States, it might seem that climate models would also be unable to tell us much about whether or not global warming will lead to drought in the southwestern United States. Recent and highly publicized predictions that the Southwest will instead become more drought-prone due to global

industry in states such as Vermont is generally projected to lose from global warming.[188]

Thus, the plaintiff states in *Massachusetts v. EPA* were a group that—at least from the point of view of their attorneys general—were likely to receive net benefits regulating GHGs under the CAA. But in asking whether it would be reasonable or even sensible to interpret the CAA broadly to regulate GHGs, the question to ask is not whether the plaintiffs might possibly benefit from such an interpretation, but whether such an interpretation can possibly be seen as consistent with the overall purposes and structure of the CAA. It cannot be. What is most strikingly clear, from both the textual structure and legislative history, is that the CAA represented a series of complex compromises among different regions and interests within the United States.

Consider first stationary source air pollution. Here, the basic structure of the CAA anticipated that places with the dirtiest air would incur the biggest costs, but probably also get the biggest health benefits, from reducing air pollution.[189] Through its scheme of coopera-

---

warming are in fact not predicted as a consequence of La Niña events becoming more frequent or severe due to global warming. Instead, these drought predictions are derived from computer predictions of changes in global atmospheric circulation patterns caused by warmer surface temperatures. Notably, climate scientist Richard Seager and his colleagues have found support for the hypothesis of a more drought-prone southwestern United States in a GCM prediction that global warming will move the Hadley cell circulation and mid-latitude westerlies poleward, thus robbing the southwestern United States of ocean moisture and subjecting it to very stable drying descending air. *See* Richard Seager et al., *Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America*, 316 SCIENCE 1181, 1183 (2007). Ironically, such drying is caused by the fact that a warmer atmosphere will also be a more humid one. Basically, the warmer the global mean temperature, the higher the latitude necessary to get cool enough temperatures for water to precipitate out as rain. Seager and his coauthors conclude that "[t]he most severe future droughts will still occur during persistent La Niña events, . . . they will be worse than any since the medieval period, because the La Niña conditions will be perturbing a base state that is drier than any state experienced recently." *Id.* at 1183–84. Of course, emphasizing the impact of possible poleward-shifting westerlies while ignoring the drought-destroying impact of possibly more frequent and/or severe El Niño events would seem at the very least to give a very incomplete and somewhat slanted picture of what a warmer climate may mean for the southwestern United States. For more on this and other troubling rhetorical strategies that have come to characterize the climate change science/policy world, see Jason Johnston, The IPCC as Expert Witness: Piercing the Rhetoric of Climate Change Advocacy Science to Reveal Fundamental Questions and Uncertainties About CO_2 and Climate Change (September 2008) (unpublished manuscript, on file with author).

188 *See supra* note 107 and accompanying text.

189 Economic studies have consistently found that since the passage of the Clean Air Act, pollution levels have fallen more in counties with poor air quality (non-attain-

tive federalism, the CAA gave states significant discretion in determining how to achieve those benefits at acceptable cost.[190] As originally written, the law would have allowed places with air quality that met federal standards—places with few present benefits from controlling pollution—to pollute their airsheds as much as they wanted until air quality had deteriorated to federal minimal levels. In concrete regional terms, the CAA imposed most of the cost of reducing air pollution on the developed midwestern and northeastern (including mid-Atlantic) regions, but those regions also got most of the benefit. Regions that did not have bad air pollution problems as of the early 1970s—such as the Southwest, Mountain West and much of the Southeast—were not required to make their good air quality even better, but rather were allowed to continue to pollute at relatively high levels and so worsen over time their ambient air quality.

As the evidence recounted above shows, global warming is expected to generate a pattern of short-to near-term costs and benefits that will differ dramatically across different U.S. states and regions. So too will the cost of reducing stationary source GHG emissions vary greatly across different states and regions. Putting the data on global warming benefits and costs together with the data on GHG emission reduction costs in concrete regional terms, it is quite clear that the northern third of the United States, and most large and relatively cold states, are likely to both benefit from global warming and also to have quite high costs of reducing stationary source GHG emissions. The southern states may well suffer from global warming but also generally have very high costs of reducing stationary source emissions. The

---

ment counties) than in attainment counties. *See* Kenneth Y. Chay & Michael Greenstone, *Does Air Quality Matter? Evidence from the Housing Market*, 113 J. POL. ECON. 376, 395–401 (2005) (finding that total suspended particulates declined more in non-attainment areas); J. Vernon Henderson, *Effects of Air Quality Regulation*, 86 AM. ECON. REV. 789, 796 (1996) (examining the effect of ozone regulation on economic activity in attainment and non-attainment regions); Kenneth Y. Chay & Michael Greenstone, *Air Quality, Infant Mortality, and the Clean Air Act of 1970*, at 17–25 (MIT Dep't of Econ., Working Paper No. 04-08, 2003), *available at* http://ssrn.com/abstract=509182 (studying the relationship between total suspended particulates and infant health). In California in particular, Clean Air Act regulation has reduced air pollution across the state, but by more in the most heavily polluted Los Angeles basin than elsewhere. Matthew E. Kahn, *The Beneficiaries of Clean Air Act Regulation*, REGULATION, Spring 2001, at 34, 34. These improvements have not come without a cost, as the more heavily polluted non-attainment counties have lost large, and relatively heavy polluting, factories to cleaner attainment areas. *See* Randy Becker & Vernon Henderson, *Effects of Air Quality Regulations on Polluting Industries*, 108 J. POL. ECON. 379, 402–05 (2000).

190 *See* Christopher S. Elmendorf, *State Courts, Citizen Suits, and the Enforcement of Federal Environmental Law by Non-Article III Plaintiffs*, 110 YALE L.J. 1003, 1022–23 (2001).

Pacific coast, northeastern, and New England regions are looking at a very uncertain mix of costs and benefits from global warming, but are likely to have relatively low costs of reducing GHG emissions.

The pollutants regulated under the CAA presented a relatively clear pattern: developed parts of the country with high pollution incurred relatively big costs but also got big benefits from reducing air pollution.[191] Regulation of GHG emissions presents a more complicated but still obviously different pattern: many, perhaps most, of the U.S. regions that have the least to lose from global warming would have the highest cost of reducing GHG emissions; the regions that would gain the most—such as the wealthy Northeast—also have relatively low costs of reducing GHG emissions. In deciding whether to vote for the CAA's regulation of conventional pollutants, federal legislators from a very large number of then relatively less developed states and districts voted for something that cost their constituents relatively little while bringing them some benefits. Had they been voting on a CAA that regulated GHG emissions, federal legislators from many of those same states would have to decide whether to vote for a law that cost their constituents an enormous amount while not only not bringing them big benefits, but probably costing them the benefits of a warmer and milder climate. If anything, one would expect that the latter vote could only be obtained through a complex compromise that gave such states and districts something in exchange for their otherwise altruistic support for curbing GHG emissions. But such speculation is unnecessary to my argument. Because of the dissimilarity in the interstate and interregional pattern of costs and benefits from GHG emission regulation, there simply is no basis for concluding that a vote for the CAA was a vote for the CAA to regulate GHG emissions.

This applies equally to the precise question of automobile tailpipe GHG emissions that was squarely at issue in *Massachusetts v. EPA*. The automobile (or mobile) source emission standards found in the CAA represent a complex compromise between the interests of a large number of legislators from states and metropolitan districts with serious auto-induced smog problems but no particular economic interest in the automobile industry (non-auto urban states and districts) and a smaller, but nonetheless influential group of legislators from states and districts that were heavily reliant upon the auto industry for jobs and local taxes (auto states and districts).[192] The CAA gave both sides something: federal emission standards for the urban non-auto legislators, but, at the insistence of the auto legislators, a

191 *See supra* Part II.A.

192 *See* BAILEY, *supra* note 50, at 144–55.

severe limitation on the legal power of the non-auto urban states and localities to set auto emission standards that were tougher than the federal standards (only California being given that ability).[193] Now whether or not a federal legislator from an urban, non-auto state or district would support federal GHG auto emission standards would depend upon the correspondence between the interests of such a 1970 vintage federal legislator in curbing the smog problem and her interest in cutting GHG emissions to potentially someday reduce the rate of increase in global average temperature. Given the very well-demonstrated acute and chronic health effects of smog in urban airsheds versus the quite widely varying impact of higher average temperatures on urban quality of life, it would not seem farfetched to suppose that many non-auto federal legislators would have found it in their constituents interests to pay more for cars so as to reduce smog, but not to pay still more just to reduce GHG emissions.

Or perhaps not. My point is precisely that because of the vast difference between the problems potentially caused by the air pollutants regulated by the CAA versus those potentially caused by GHG emissions, a vintage 1970 federal legislator's vote on the CAA tells us virtually nothing about how she would vote on the question of whether the CAA should include GHG emissions. To interpret the CAA as saying anything about the regulation of GHG emissions is fundamentally for the Court to force a vote upon the federal legislators of the year 1970 that was never even contemplated. Even more, as I shall argue in the next Section, by such an interpretation, the Supreme Court of 2007 not only took a vote that was never taken by the Congress of 1970, but may well have significantly impeded a vote on GHG emission regulation by the Congress of today.

F. GHG Emission Reduction Entails Short-Term Costs for Uncertain, Long-Term Benefits, and a Bargain That Was Not Contemplated by Congress in Drafting the CAA, and Which a Rational Legislator Would Surely Reject

It might be argued that even if global warming is likely to bring short-term benefits to many parts of the United States, and even if the costs of reducing GHG emissions are very unfairly distributed, falling mainly on poor and rural households, Congress would still have wanted EPA to regulate GHGs under the CAA because of global

193 Under the Clean Air Act, federal regulations limiting emissions from new cars sold in the United States preempt the regulations of all states except those of California, which other states are permitted to follow. CAA §§ 202, 209(a), 42 U.S.C. §§ 7521, 7543(a) (2000).

warming's potentially catastrophic long-term consequence. This argument may be easily defeated: there is nothing in the text or legislative history of the CAA to suggest that Congress contemplated that greenhouse gas emissions and the global warming problem would be covered by the CAA. Indeed, there is nothing in the text or legislative history of the CAA to suggest that Congress was in the least bit concerned with a possibly beneficial air "pollutant" whose harmful effects—if they occurred at all—would be felt not by the current generation, nor the generation after that, nor the next; which would indeed not be felt for over a century and perhaps longer.

Such neglect of possible, albeit highly uncertain, future benefits from GHG emission reduction might be ascribed simply to legislative myopia: to the socially undesirable tendency of legislators to care only about conferring short-term benefits and avoiding (or concealing) short-term costs so as to ensure their own continued electoral success. While it is certainly true that legislators in all democracies often behave in myopic ways, even the most rational and future-oriented legislator might correctly decide that it is not in the interest of far-off generations to control GHG emissions today. One reason that a rational legislator might behave in this way is because the future is far away, and economic growth will make it rational to invest today in growth and then use the proceeds later to reduce GHG emissions.[194] This is the usual economic justification for such long-term discounting, and it is by now quite well known.

But there is another reason for rational failure to control GHG emissions today, one that is much less well known. The argument is somewhat complex, and here I can only provide its outlines. The basic idea is this: models of the impact of global warming are highly uncertain and new, and therefore likely to contain many errors. Over time, the models may improve, or they may fail to improve.[195] How-

194 This important justification for postponing investments in GHG emission reduction is a consequence of standard assumptions made in neoclassical growth models first applied to climate change by William Nordhaus. For a clear recent summary, see William Nordhaus, *Critical Assumptions in the Stern Review on Climate Change*, 317 SCIENCE 201 (2007).

195 The kind of learning that I implicitly assume here may be much too optimistic. In a recent paper Gerard H. Roe and Marcia B. Baker have elegantly shown how asymmetric uncertainty—with a very long right tail in the distribution of predicted change in global average temperature, ΔT, from a doubling of tropospheric CO_2 relative to preindustrial levels—"is not an artifact of the analyses or choice of model parameters. It is an inevitable consequence of a system in which the net feedbacks are substantially positive." Gerard H. Roe & Marcia B. Baker, *Why Is Climate Sensitivity So Unpredictable?*, 318 SCIENCE 629, 631 (2007). In other words, if, as climate models presume, positive feedbacks from CO_2 predominate (e.g., ice sheets melting, lowering

ever, every year in which predictions of the models fail to be validated represent a data point indicating that the models are lacking and in important ways incorrect. Now suppose that a super rational member of Congress believes model predictions of serious climate change in the far distant future, say one hundred years. At the same time, however, legislation requiring costly actions to reduce GHG emissions cannot get majority support unless Congress is persuaded that some very severe harm from climate change will occur much sooner. Such relatively imminent harms will then be the official justification for passing GHG reduction legislation. But if legislation is passed with the express purpose of preventing imminent harm from global warming, and in fact temperatures increase very slowly (or not at all) in the near future and the near-term harm that justified costly legislative GHG reduction requirements does not occur, there will be enormous pressure on Congress to amend the law to weaken its GHG reduction requirements (a very similar story in fact took place with the CAA itself).[196] Once weakened by future amendment, it may be very difficult, if not politically impossible, to return to a statute that adequately protects against the predicted long-term consequences. In short, by passing legislation based on predicted short-term consequences, Congress may drastically increase the stakes in the accuracy of short-term predictions from climate models. But climate models cannot make accurate short-term (five-to-ten year) predictions.[197] Hence, the justification for legislation imposing present day costs for the far-off future will likely fail, leading to legislative repeal and a worsened status quo than if GHG emission requirements were postponed.

albedo, leading to higher surface temperatures, more melting, and so on), then such models will always attach some positive probability to very high potential temperature increases. Perhaps most importantly, "foreseeable improvements in the understanding of physical processes, and in the estimation of their effects from observations, will not yield large reductions in the envelope of climate sensitivity." *Id.* at 631.

196 *See* BAILEY, *supra* note 50, at 167–74.

197 This is because, among other reasons, they cannot predict ENSO and NAO events, which are the major determinants of serious climate events on these timescales. *See* Peter N. Spotts, *How Can You Predict Global Warming If You Can't Predict Rain?*, CHRISTIAN SCI. MONITOR, Oct. 18, 2007, at 14, *available at* http://csmonitor.com/2007/1018/p14s01-wogi.html.

III. By Requiring That EPA Regulate GHG Emissions Under the CAA, the Supreme Court Has Reduced the Likelihood That Congress Will Pass Economically Sound and Environmentally Effective Global Warming Legislation

As explained in the previous Part of this Article, what the Supreme Court did in *Massachusetts v. EPA* was to allow (some) states that perceive that they will gain from federal climate change regulation to bring a lawsuit forcing a federal agency to regulate to protect their interests, at the possible expense of other states and regions.[198] In this Part, I explain how, by compelling EPA to regulate, the Court has radically changed the stakes in congressional bargaining over possible federal legislation and consequently made socially desirable, efficient federal greenhouse gas legislation much less likely.

In the face of predicted sea level increases of twenty feet in Massachusetts and southwestern drought more severe than at any time since the medieval period, one might have expected that Congress would long ago have passed climate change legislation. It has not. A rationale for allowing Massachusetts to have standing to sue to force rulemaking under the CAA might be that it will force congressional action. However, congressional bargaining in the shadow of rulemaking that has been forced upon the agency—the result in *Massachusetts v. EPA*—is likely to be far different from congressional bargaining without such ongoing regulation. By forcing EPA to regulate GHG emissions under a statute that is not designed to regulate emissions with the impact of GHGs, the Court has made socially desirable federal climate change legislation less likely.

The reason is this. The states have quite divergent interests in greenhouse gas regulation. This is a clear lesson of the discussion thus far and is further illustrated by Figure 1, which shows the radical differences in state per capita CO_2 emissions as of 2005. Were the matter left to Congress—the body that actually wrote the CAA—then presumably congressional representatives from some states—such as Massachusetts—would be lobbying the agency to regulate, while others—such as Texas—would lobby the agency not to regulate

198 *See supra* Part I, Part II.E; *see also* Adler, *supra* note 173, at 38 ("Once the EPA makes the required finding under section 202 [the automobile tailpipe provision], it will be child's play to force greenhouse gas emission regulation under other Clean Air Act provisions."). For the same conclusion, but from the perspective of the plaintiffs in *Massachusetts v. EPA*, see Heinzerling, *supra* note 32, at 5 ("[T]he legal reasoning behind EPA's decision not to control greenhouse gas emissions in setting New Source Performance Standards for power plants has been upended by the Court's decision.").

GHGs. The agency would face pressure from both GHG regulation winners and GHG regulation losers. In this game, one would expect GHG regulatory losers to argue, inter alia, that even if GHG emissions should be regulated, the way to do so is not by imposing traditional automobile emission limits or other traditional command control requirements under the CAA, but instead through a cap and trade regime, or perhaps entirely differently, through a system of subsidies for the development of carbon sequestration technologies. Whatever EPA decided, it would have had an opportunity to hear from precisely those members of Congress who would be the ones to respond legislatively to whatever the agency decides. Moreover, regulatory losers in Congress might be able to stop GHGs from being regulated under the CAA simply by lobbying the agency, without actually having to introduce legislation.

What the Court has done by allowing certain state attorneys general to bypass congressional bargaining is to shift radically the legislative burden in a way that effectively forces legislative action. After the decision in *Massachusetts v. EPA*, federal legislators who oppose GHG emission control under the current CAA cannot simply lobby the agency not to promulgate such regulations, for the agency is now under a court order requiring it to issue them.[199] Instead, they must take the very costly step of actually introducing legislation to stop the agency's court-ordered rulemaking.

The Court has not only, however, increased the cost to federal legislators of influencing agency behavior. More importantly, and non-intuitively, by unilaterally altering the status quo—by forcing what is likely to be clearly suboptimal GHG emission control under the CAA—the Court has provided some benefits to jurisdictions that are net beneficiaries, while imposing costs on others. This reduces the marginal gain from new legislation to beneficiary jurisdictions. And while cost-bearing jurisdictions could lower their cost with a better choice of instruments, whether this is of much value to beneficiary jurisdictions depends upon the slope of the marginal benefit curve. Generally, with a flat marginal benefit curve, meaning relative constant marginal benefit, shifting down the marginal cost curve means a big potential increase in the optimal level of reduction and big potential increases in benefits. With a very steep marginal benefit curve,

199 It is not of course literally impossible to lobby an agency that is under a court order to issue regulations. My statement implicitly assumes that the cost to an agency from failing to comply with the court order is sufficiently high that members of Congress cannot offer a sufficiently high reward to induce the agency to violate the court order.

meaning marginal benefits that fall quickly, as the level of GHG reduction increases, there will be relatively small net benefits from reducing marginal cost. If what legislators really need to say is that some decrease in GHGs has been achieved, so that the marginal benefit is quickly decreasing beyond some point, then we are in the latter case, and the "better" policy provides primarily lower costs, and legislators from beneficiary jurisdictions would not, absent side payments in legislative deals, have a big incentive to legislate. Note that such a process is precisely the sort that would generate market gains from trade.

But the legislature is not a market, and just because an approach would improve upon the regulatory status quo does not mean it will be enacted. The currency for legislative deals is generally the exchange of policies and programs, and whether or not such an exchange can be implemented is highly uncertain and dependent upon the overall legislative agenda at a particular point in time. This is to make again the very important point that the Coase Theorem does not apply to legislative bargaining.[200] The reason is that efficient, Coasean bargaining requires that winners from GHG emission reductions be better off with an efficient reduction than with a bigger, but inefficient reduction, at least after side payments by the cost-bearing regions. But within a legislature, such side payments are unlikely. Suppose, for example, EPA proposes automobile GHG emission regulation that would cost GHG control losers one hundred dollars and yield GHG control winner states a forty dollar political benefit. If for seventy dollars the cost-bearing states could generate a thirty-five dollar benefit, then both sides would be better off if the cost-bearers adopted the cheaper approach and then paid the beneficiaries any amount above five dollars. But such side payments, feasible among private plaintiffs, are generally not possible to make within the federal legislature. They would require interstate transfers that are generally possible only in the form of in-kind deals struck in the centralized legislature. Without such transfers, the state plaintiffs have every incentive to stick with the regulation—the inefficient one hundred dollar fix.

Even more seriously, even assuming that state attorneys general have the same incentives as do congressional representatives, the Court's decision in effect allows them to get greenhouse gas emission

200 *See* Daron Acemoglu, *Why Not a Political Coase Theorem?: Social Conflict, Commitment, and Politics*, 31 J. COMP. ECON. 620, 648 (2003). *But see* DONALD WITTMAN, THE MYTH OF DEMOCRATIC FAILURE 160 (1995) (arguing for use of the Coase Theorem in democratic politics).

control for free, whereas in the federal legislative arena, representatives from states that are net beneficiaries from GHG emission controls would have to bargain with representatives from states that are net losers from such controls. What one sees in the *Massachusetts v. EPA* suit is a set of plaintiff states with relatively little to lose, and hence much to gain, from GHG emission controls on automobiles. On the other side of that litigation, one saw states whose representatives perceive that such controls will generate net costs, rather than benefits, for them. Unlike Congress, the defendant states in the litigation, regardless of their numbers, could not vote to stop regulation. Only the Justices have a vote. Even if EPA were to get it right, and find GHG emission controls whose aggregate benefits exceed their aggregate costs, it is still possible that the majority of states would be net losers from such controls and that their federal legislative representatives would have successfully opposed legislation implementing such controls.

A final and very significant problem with the Court's expansive reading of the CAA to include CO_2 emissions is that not only does the decision change the status quo, but it also changes legislative expectations about how the Court would likely interpret global warming legislation. After *Massachusetts v. EPA*, legislators should rationally expect very broad, expansive interpretation of such legislation. Especially for legislators who are moderate on global warming—representing constituencies that perceive both benefits and costs from legislation curbing GHG emissions—the expectation of such expansive judicial interpretation threatens to increase the costs of GHG curbs much above what such legislators would actually support. As shown recently by Daniel B. Rodriguez and Barry R. Weingast, if such legislators (often moderates from the minority party) perceive that "the deals they negotiate in order to support cloture will be undone through expansionary readings by the courts, then they are not likely to bother negotiating these deals in the first place."[201] Were a moderate legislator to support, for example, "economically justifiable" caps on GHG emissions, then she would need to worry that the Court would broadly interpret "economically justifiable" to authorize extremely onerous GHG caps.

The prediction that the Court's decision in *Massachusetts v. EPA* has if anything lessened incentives for innovative new federal climate change legislation seems to be borne out by federal legislative developments thus far. In the Energy Independence and Security Act of

201 Daniel B. Rodriguez & Barry R. Weingast, *The Paradox of Expansionist Statutory Interpretations*, 101 NW. U. L. REV. 1207, 1240 (2007).

2007,[202] Congress: (1) set a new target for automobile and light truck fuel economy of thirty-five miles per gallon, to be achieved by 2020; (2) mandated a large increase in the minimum annual level of renewable fuel in U.S. transportation fuel, rising from nine billion gallons in 2008 to thirty-six billion gallons by 2022; and (3) set new efficiency standards for light bulbs and several other consumer household appliances. None of these policies are new[203] and none are focused specifically on reducing greenhouse gas emissions. Although they may have that effect, such an impact is hardly guaranteed. Meeting the new auto fuel efficiency standards by shifting fleets to diesel could, for example, actually increase CO_2 emissions even while reducing oil consumption. The Energy Independence and Security Act established a goal of producing fifteen billion gallons of corn-based ethanol by 2015.[204] However, the conversion of forests and grasslands to grow corn as a feedstock for ethanol may generate large net carbon emissions.[205] Sensibly, the Energy Independence and Security Act requires that by 2016, all increases in renewable fuels must be met

202 For a summary of this act's provisions, see generally FRED SISSINE ET AL., CONG. RESEARCH SERV., ENERGY INDEPENDENCE AND SECURITY ACT OF 2007 (2007).

203 As pointed out earlier in the Energy Policy Act of 2005, Congress tripled the ethanol requirement in automobile fuel. *See supra* note 160. The Energy Independence and Security Act of 2007, further increases this ethanol requirement and requires that ethanol come from sources other than corn by 2016. *See* Energy Independence and Security Act of 2007 §§ 201–202, 42 U.S.C.A § 7545 (West 2003 & Supp. 2008) (effective Jan. 1, 2009). This latter aspect of the bill is, of course, completely incredible: after having subsidized corn-based ethanol production for, by then, almost 20 years, it is hard to believe that the 2016 Congress would really stick to its earlier commitment to pull subsidies for corn-based ethanol.

204 Energy Independence and Security Act of 2007 §§ 201–202, 42 U.S.C.A § 7545 (West 2003 & Supp. 2008) (effective Jan. 1, 2009).

205 One study, for instance, shows that when account is taken of the carbon sequestration lost when forest and grasslands are converted to biofuel cropland, even biofuel production from switchgrass increases CO_2 emissions by at least fifty percent. *See* Searchinger et al., *supra* note 159, at 1238. Another recent study estimates that when forests, peatlands, savannahs, and grasslands are lost in order to produce other biofuel crops such as corn and sugarcane, such conversion releases *between 17 and 420 times more* CO_2 than the annual GHG reduction provided by burning the biofuels instead of gasoline. *See* Fargione et al., *supra* note 159, at 1235. Both of these studies have been persuasively criticized as relying on a number of unreasonable, relatively arbitrary assumptions about things such as the amount of unused land available for biofuel crop production and how much feed corn is diverted to produce ethanol. *See* Letter from Michael Wang, Argonne Nat'l Lab. & Zia Haq, U.S. Dep't of Energy, to *Science Magazine* (Mar. 14, 2008), *available at* http://www.transportation.anl.gov/pdfs/letter_to_science_anldoe_03_14_08.pdf.

with biofuels derived from sources other than corn.[206] While there is evidence that biofuels made from grasses, wood, and waste biomass generate large net GHG emission reductions, the magnitude of these reductions is unclear.[207]

It would thus be fanciful to argue that what Congress has done in the Energy Independence and Security Act of 2007 is to take dramatic and effective action on the problem of GHG emissions and climate change. Instead, Congress has, if anything, simply used the general panic over climate change as an excuse for passing legislation that benefits certain special interest groups while quite possibly *increasing* GHG emissions. As for legislation actually focused on the climate change problem, it is true that over the past several years, there have been a number of bills introduced in Congress that would set up comprehensive climate change regulatory regimes.[208] Virtually all of these are what economists would call market-based in that they would create GHG cap and trade regimes (the vast majority) or a carbon tax.[209] As I discuss below in the Conclusion of this Article, the widespread preference for cap and trade global warming regulatory regimes is, in my view, based on an overly facile belief that a policy instrument that has seemed to work relatively well for some air pollutants (in the United States, sulfur dioxide and nitrous oxides) will also be appropriate for a radically different set of air emissions whose reduction involves virtually every sector of the U.S. economy.[210]

It is true that in the spring of 2008, the Senate came close to voting on the Lieberman-Warner Climate Security Act of 2007,[211] which would have implemented a greenhouse gas cap and trade scheme.[212] Lieberman-Warner was a gargantuan and enormously complex piece of legislation, with complicated provisions setting up an entire new system of transfer payments and greenhouse gas offsets to cushion the impact on the poor and various U.S. regions and industrial sectors (for example, agriculture). The radical and fundamental differences between the Lieberman-Warner greenhouse gas cap and

206 *See* Energy Independence and Security Act of 2007 §§ 201–202, 42 U.S.C.A § 7545 (West 2003 & Supp. 2008) (effective Jan. 1, 2009).

207 *See* BILL JACKSON ET AL., THE BOUNTY OF BIOFUELS 2 (2008), http://www.boozallen.com/media/file/Bounty_of_Biofuels.pdf; Roger A. Sedjo, Commentary, *Biofuels: Think Outside the Cornfield*, 320 SCIENCE 1420, 1420 (2008).

208 *See generally* Victor B. Flatt, *Taking the Legislative Temperature: Which Federal Climate Change Legislative Proposal Is "Best"?*, 102 NW. U. L. REV. COLLOQUY 123 (2007).

209 *See id.* at 134–36.

210 *See infra* notes 244–47 and accompanying text.

211 S. 2191, 110th Cong. (2007).

212 *See id.*

trade program and the Clean Air Act provide further support for my argument that Congress simply could never have contemplated regulating greenhouse gas emissions under the CAA. My prediction that EPA regulation under the CAA will, counter-intuitively, lessen the chance that Congress will pass something like Lieberman-Warner remains to be tested. Although over a year and a half has passed since the Court's decision in *Massachusetts v. EPA*, EPA has not acted to promulgate greenhouse gas emission regulations under the CAA. What EPA has done instead is to issue an Advance Notice of Proposed Rulemaking in which it sets out a variety of reasons—in many cases paralleling parts of my argument—as to why it would be difficult or even impossible to sensibly regulate greenhouse gas emissions under the CAA's regulatory structure.[213] As EPA has not yet acted to regulate GHGs under the Clean Air Act, we do not yet have a test for my hypothesis.[214]

It must be stressed that the foregoing analysis has been concerned with the impact of EPA regulation of greenhouse gases under the Clean Air Act on the likelihood of federal global warming legislation. I have been concerned with the case where EPA does in fact promulgate greenhouse gas regulations under the Clean Air Act. EPA has not yet promulgated such regulations. Instead, the current situation is most accurately described as one where regulation is *threatened*. On the analysis of legislative costs and benefits set out above, threatened legislation is likely to have political incentive effects that are opposite to those created by promulgated regulation. The reason is quite straightforward: the threat of regulation means that federal legislators who support global warming legislation see a risk of losing some of the political benefits available to them from acting on global warming. Rather than allowing the agency to act first, and reducing the benefit to them from legislating, supporters of federal legislation may see a reason to act quickly, to beat the agency to the punch, as it were. As for members of Congress whose constituents are likely to be net losers from global warming, early congressional action gives them

213 *See* Regulating Greenhouse Gas Emissions Under the Clean Air Act, 73 Fed. Reg. 44,353, 44,362–71 (July 30, 2008) (to be codified at 40 C.F.R. Ch. I) (discussing the potential transportation costs, agricultural burdens, disparate regional impacts, questionable effectiveness, and various collateral effects of regulating GHGs under the CAA).

214 There has been widespread speculation, however, that an Obama administration would move quickly to promulgate such regulations, and thus such an administration would likely generate a test of my hypothesis regarding the likelihood of congressional reaction to costly and sub-optimal regulations. *See* Editorial, *Obama's Carbon Ultimatum*, WALL STREET J., Oct. 20, 2008, at A18.

an opportunity to attempt to at least lessen the cost of global warming regulation to their constituents. Still, if they believe that regulation under the Clean Air Act will likely prove to be unworkable and easily stymied in practical implementation, then they may well oppose legislation which is superior on cost-benefit grounds to regulation under the Clean Air Act precisely because such legislation is likely to result in actual compliance costs far sooner than under Clean Air Act regulation.

IV. THE INTERNATIONAL NATURE OF THE GLOBAL WARMING PROBLEM NOT ONLY JUSTIFIES EPA IN NOT REGULATING GHGS UNDER THE CAA BUT ALSO MEANS THAT CONVENTIONAL REGULATORY INSTRUMENTS WILL NOT BE EFFECTIVE IN ADDRESSING GLOBAL WARMING

According to the majority, under the statutory command that EPA must determine whether an air pollutant "cause[s] or contribute[s] to, air pollution which may reasonably be anticipated to endanger public health or welfare,"[215] EPA can "avoid taking further action only if it determines that greenhouse gases do not contribute to climate change or if it provides some reasonable explanation as to why it cannot or will not exercise its discretion to determine whether they do."[216] According to the majority, EPA's reasons for not regulating greenhouse gases—the existence of executive branch voluntary greenhouse gas reduction programs, the impact of domestic regulation on the President's ability to negotiate to reduce developing nation GHG emissions; and that curtailing motor–vehicle GHG emissions alone would be an inefficient, "piecemeal" approach to regulation—"have nothing to do with whether greenhouse gas emissions contribute to climate change."[217] And again: "Nor can EPA avoid its statutory obligation by noting the uncertainty surrounding various features of climate change . . . . If the scientific uncertainty is so profound that it precludes EPA from making a reasoned judgment as to whether greenhouse gases contribute to global warming, EPA must say so."[218]

Now the narrow legal answer to this question involves a determination of whether an agency can ever refuse to inquire into whether an air emission reasonably endangers public health or welfare on the ground that there is simply too much uncertainty over the effects of

215 42 U.S.C. § 7521(a)(1) (2000).

216 Massachusetts v. EPA, 127 S. Ct. 1438, 1462 (2007) (citing 42 U.S.C. § 7521(a)(1)).

217 *Id.* at 1463.

218 *Id.* (citation omitted).

the emission to make such a finding. Had Congress specifically and explicitly told EPA to regulate GHG emissions, then the agency would obviously have lacked authority to defer regulation on the ground that the effects of GHGs are too uncertain.[219] But there is no such command to the agency to regulate GHGs anywhere in the CAA, and the legal question under the *Chevron* test is then whether the agency's decision to defer its consideration of GHG emission regulation could be understood as a reasonable exercise of its statutory discretion.

For Justice Scalia writing in dissent, the reasons given by EPA for its deferral—its desire to avoid a fractured, piecemeal approach to GHG emission regulation, and to avoid interfering with executive branch climate change programs and international negotiations—were eminently reasonable, precisely the kinds of "considerations executive agencies *regularly* take into account (and *ought* to take into account) when deciding whether to consider entering a new field."[220] Moreover, as Justice Scalia noted, EPA did explain the basis for its view that there was too much uncertainty to justify GHG emission regulation at the current time: the 2001 National Research Council Report.[221]

In rejecting EPA's deferral of GHG emission regulation under the CAA, the Supreme Court majority repeatedly conflates uncertainty regarding "various features of climate change" with uncertainty over whether "greenhouse gases contribute to climate change."[222] However, as the majority notes, the statutory question is precisely whether GHGs cause a form of "'air pollution which may reasonably be expected to endanger public health or welfare.'"[223] That is, under the language of the statute, the precise legal question is not whether there is too much uncertainty over the role of GHGs in causing climate change for the agency to regulate; it is instead whether there is so much uncertainty over whether GHGs may "'reasonably be expected to endanger public health or welfare'"[224] that the agency does not need to engage in rulemaking.

---

219 *See* Chevron U.S.A. Inc. v. Natural Res. Def. Council, Inc., 467 U.S. 837, 842–43 (1984) (stating that when reviewing an administrative agency's construction of a statute it administers, a court must first look for a clear intent expressed by Congress and, upon no intent being found, determine if the agency's interpretation is based on a permissible construction of the statute).

220 *EPA*, 127 S. Ct. at 1473 (Scalia, J., dissenting).

221 *Id.* at 1474.

222 *Id.* at 1463 (majority opinion).

223 *Id.* at 1444 (quoting 42 U.S.C. § 7601(a)(1) (2000)).

224 *Id.* (quoting 42 U.S.C. § 7601(a)(1)).

Here, as in the earlier sections of this Article, I want to look at the issue of uncertainty and regulatory delay raised in *Massachusetts v. EPA* from the point of view of pragmatic statutory interpretation, inquiring into whether the purposes, interests, and policies that supported the CAA would also reject EPA's reasons for failing to regulate GHGs under that statute. Under this approach, one evaluates the reasonableness of EPA's decision to defer regulating GHG emissions under the CAA by asking: What kind of uncertainty do we have with respect to the actual harm from climate change and how does it compare with the harms that the CAA was drafted to ameliorate?[225]

The air pollutants that are regulated under the CAA were all perceived by Congress to be presently causing harm to human health or public welfare.[226] Congress delegated to EPA the job of ensuring that similar pollutants were controlled and reduced to appropriately "safe" levels, with due account for changes in scientific knowledge regarding the impacts of pollutants at various levels of ambient concentration.[227] To be sure, there is plenty of scientific uncertainty in the regulation of statutory air pollutants under the CAA; uncertainty in particular over whether various human health harms are statistically related to the ambient concentration level of various regulated pollutants. But with virtually every pollutant that is regulated under the CAA, it is undisputed that at sufficiently high ambient concentrations, that pollutant will cause some statistically significant harm to the human health of members of the present generation of Americans who are exposed to the pollutant.[228]

Things are quite different with GHG emissions. Even were one to view the recent IPCC Report on the impacts of global warming with an attitude of complete credulity and blind faith, the most that one can say is that the report recounts various changes that have occurred due to global warming—as for example with the breeding seasons and ranges of various species—but few if any significant harms to the health or welfare of Americans.[229] The Report is concerned primarily with projecting future harms that its authors believe will occur sometime late in the present century under various future climate scena-

225 A complete answer to this question requires a sustained analysis of the causes and treatment of uncertainty in predicting the human consequences of climate change. I give that complete answer elsewhere, and incorporate here only the most pertinent points.

226 *See supra* notes 38–48 and accompanying text.

227 *See* 42 U.S.C. § 7409 (2000).

228 *See supra* Part II.A.

229 *See, e.g.*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 121, at 8–20.

rios, such as the potentially catastrophic flooding along the American Atlantic and Gulf coasts and severe drought in the Southwest discussed earlier.[230]

Now as with any regulatory decision, if EPA decides to regulate GHGs because of these projected harms, two types of error are possible. A Type I error occurs when the regulator incorrectly takes action: the regulation was either not needed or is ineffective.[231] In the case of global warming, a Type I error means that GHG emissions are reduced and the harms do not occur—for example, the American climate becomes warmer and everywhere wetter, and there is adaptation to sea level rise, with people on balance being better off as they migrate to the upper Midwest—and the agency has inflicted a gigantic loss across the economy, which would not be approved of by Congress at the time. Crucially, for federal regulation of GHG emissions, there is another potential source of Type I error: EPA could regulate U.S. GHG emissions, but China, India, and other developing countries could fail to control GHGs, in which case the harm from global warming would occur despite U.S. costs to cut GHG emissions, so that regulation would have generated costs but no benefits.[232] With global warming there are two types of Type I error: regulating when global warming in fact generates little harm to the United States, and regulating when global warming is indeed harmful to the United States but occurs despite U.S. GHG emission reductions.

Type II error arises when the agency fails to regulate GHG emissions and harm occurs.[233] Such an error would arise when global warming is harmful, and when other nations or subnational governments fail to implement regulations that are sufficient to offset the American failure to regulate.

Now consider the regulation of traditional air pollutants. Type I errors for traditional air pollution regulation arise when EPA regulates—meaning levels of air pollution are reduced by some amount—but the existing levels were not actually harmful. In this case, there is an economy-wide wasted cost of pollution reduction. In the case of

230 *See supra* notes 185–87 and accompanying text.

231 *See* Mark A. Hall & Ronald F. Wright, *Systematic Content Analysis of Judicial Opinions*, 96 CAL. L. REV. 63, 95 n.133 (2008).

232 *See* Reimund Schwarze, *Liability for Climate Change: The Benefits, the Costs, and the Transaction Costs*, 155 U. PA. L. REV. 1947, 1951 (2007) ("If the United States were to establish a crushingly expensive regime ascribing liability to individual polluters, there would be a serious incentive to relocate GHG-intensive industries to countries such as China and India, which have no or almost no restrictions on GHG emissions and no liability for climate-related damages.").

233 *See* Hall & Wright, *supra* note 231, at 95 n.133.

traditional air pollutants, Type II errors arise when the agency fails to regulate, but the status quo pollution level is indeed harmful, and states and local governments do not take adequate steps to reduce it.

Comparing the regulation of GHGs with the regulation of traditional air pollutants, we can see the enormous significance to rational regulatory deliberation of the fact that unlike the primary focus of the CAA—the local impacts of primarily localized air pollution—global warming is all about the local effects of global atmospheric change. The difference comes not in the Type II errors: both with traditional air pollution and GHGs, Type II errors arise when global warming generates harm to the United States but other governmental actors—states and localities in the case of traditional pollutants, other nation states plus subnational governmental units in the case of GHGs—fail to take sufficient action to offset EPA's failure to act. The difference comes instead in the nature of Type I errors.

In general, a Type I error occurs when the costs of regulation are incurred but with no benefit. With traditional domestic air pollution, a Type I error occurs only if there is indeed no harm at the status quo levels of pollution (so regulatory reduction was an error).[234] With global warming and GHG gases, however, a Type I error can arise both when global warming does not generate net harm to the United States and when other nations fail to regulate and continue to increase their own GHG emissions, so that U.S. GHG regulation generated no decrease in harm. With traditional air pollutants, a sufficiently large reduction in domestic emissions necessarily reduces harm if indeed the existing status quo level of pollution was harmful. With GHG emissions, even if GHG–induced global warming is harmful, it is possible that even the complete elimination of U.S. GHG emissions will not reduce such harm, because increasing emissions from other nations more than offset the U.S. reduction.[235] In particular, China is now not only the world's largest CO_2 emitting nation by far, but is predicted to continue to massively increase its CO_2 emissions, with China's predicted increase dwarfing emissions reductions made by all Kyoto signatories.[236]

234 Somewhat more concretely, Congress was concerned in the CAA with local or regional air pollution problems that could actually be solved through State Implementation Plans. *See, e.g.*, Train v. Natural Res. Def. Council, Inc., 421 U.S. 60, 84–87 (1975).

235 *See* Faulk & Gray, *supra* note 155, at 66 (stating that the United States accounts for only twenty-three percent of the world's CO_2 emissions).

236 Due to a number of factors—including inaccuracies in data supplied by the Chinese National Bureau of Statistics and the existence of a potentially large Chinese black market in coal production and marketing—there is a great deal of uncertainty

All of this is to say that at the best, the power of EPA is extremely limited in the case of taking effective action to reduce the harm from global warming relative to its power to reduce the harm from traditional pollution. But matters may in fact be worse than this. It may be that the more effective EPA is in reducing GHG emissions, the weaker the incentive will be for other countries to do the same. Such scenarios are in fact very easy to imagine.

Suppose that the United States reduces its GHG emissions but global warming seems not to be accelerating as predicted. Under such circumstances, there will be less pressure on late movers to act. Suppose somewhat differently that the United States reduces its GHG emissions and the atmospheric stock level of CO_2 begins—for whatever reason—to stabilize or even decline. In this scenario, there is once again less pressure on other countries to act.[237] Suppose finally that the United States reduces GHG emissions but there is no

---

in estimates of China's CO_2 emissions. However, allowing for this uncertainty, two recent, independent studies estimate that China's CO_2 emissions exceeded those of the United States in 2006. Jay S. Gregg et al., *China: Emissions Pattern of the World Leader in CO_2 Emissions from Fossil Fuel Consumption and Cement Production*, GEOPHYSICAL RES. LETTERS, April 2008, at L08806, at 1; NETH. ENVTL. ASSESSMENT AGENCY, GLOBAL CO_2 EMISSIONS (2008), http://www.mnp.nl/en/publications/2008/GlobalCO2emissionsthrough2007.html. Given the uncertainty in estimates of Chinese CO_2 emissions, and the likelihood that annual data underestimate emissions (due to incentives to overstate end-of-year production, so as to meet quotas, and hence understate early year production), Gregg and colleagues point out that it is possible that Chinese emissions could have passed U.S. emissions as early as 2004. Gregg et al., *supra* at 4. Auffhammer and Carson also estimate that China CO_2 emissions surpassed those of the United States in 2006. Maximilian Auffhammer and Richard T. Carson, *Forecasting the Path of China's CO_2 Emissions Using Province-Level Information*, 55 J. ENVTL. ECON. & MGMT. 229, 229 (2008). In addition, using models that accurately capture the cost of replacing old, dirty capital, they forecast that by 2010, China's carbon emissions will increase by 600 million metric tons relative to 2000, dwarfing the 116 million ton reduction that Kyoto signatories are committed to bringing about by 2010. *Id.* at 245.

237 This particular scenario is a version of the general game modeled by Michael Hoel who presumes that the higher the emissions reduction by one country, the lower the marginal benefit—in terms of reduced harm—to reductions by another country. Michael Hoel, *Global Environmental Problems: The Effects of Unilateral Actions Taken by One Country*, 20 J. ENVTL. ECON. & MGMT. 55, 59–60 (1991). Hence although total emissions must decline, late movers free-ride off the emissions reductions of early movers. Moreover, under such conditions, a unilateral commitment to reduce emissions by one country unambiguously harms its position in negotiating with the other country for an emissions reduction treaty. *Id.* at 63–64. Erling Moxnes and Eline van der Heijden provide evidence demonstrating that investments to reduce a public bad by leaders reduces subsequent investment by later movers. Erling Moxnes & Eline van der Heijden, *The Effect of Leadership in a Public Bad Experiment*, 47 J. CONFLICT. RES. 773, 781–82 (2003). Moxnes and van der Heijden find that followers invest, on average, thirteen percent less in the public bad when there is a leader setting the good

new apparent harm from global warming. Once again, there will be less pressure on late movers to act.

There are, on the other hand, scenarios under which unilateral action by the United States could increase the incentives for other nations to act to reduce GHG emissions. If the atmospheric stock of CO_2 continues to increase despite U.S. GHG reductions, and global average temperature and harms from such temperature changes also continue to increase, then unilateral U.S. action could increase the incentive of late-moving countries to act by revealing that the cost of action is lower than expected. In other words, were U.S. action to generate effective and unexpectedly cheap technologies for GHG reduction, and were late-moving countries such as China to perceive that they had become pivotal—in the sense that by reducing their emissions, they could in fact reduce harms suffered by their own populations[238]—then early U.S. action could sufficiently lower the cost of emission control that would spur action by late movers.[239] Still, even if unilateral U.S. action revealed unexpectedly cheap and effective technologies for reducing GHG emissions, and late moving countries would realize a self-interested benefit from reducing their own GHG emissions, whether such late movers would take still costly action to reduce GHG emissions would depend upon how quickly they are growing, how high their per capita income has grown, and in general on the whole set of factors determining the domestic demand for and supply of pollution reduction efforts. For pollutants such as sulfur dioxide, there is evidence of an environmental "Kuznets Curve," whereby emissions at first increase with industrialization and national per capita income but then eventually fall for sufficiently high levels of wealth.[240] There is no evidence of a consistent relationship of this sort between national income and CO_2; instead, CO_2 emissions mono-

example as opposed to a situation with no leader. *Id.* This produces benefits also to the leaders but not enough to recover all the costs of taking a leading position.

238 Note that the existence of a treaty could significantly enhance the positive impact of early-moving behavior by essentially reducing the potential harm from treaty defection to treaty adherents. *See* Jean-Christophe Pereau & Tarik Tazdait, *Cooperation and Unilateral Commitment in the Presence of Global Environmental Problems*, 20 ENVTL. & RES. ECON. 225, 237 (2001). This, of course, is a further argument that a purposive Congress would not have intended to mandate U.S. GHG reductions without a treaty in place.

239 *See* Urs Steiner Brandt, *Unilateral Actions, Case of International Environmental Problems*, 26 RES. & ENERGY ECON. 373, 389 (2004).

240 The "Environmental Kuznets Curve" refers to the observed tendency for ambient pollution to at first increase but then decrease as national per capita GDP increases, thus giving rise to an inverted U-shaped relationship between per capita income and pollution. *See* Arik Levinson, *Environmental Kuznets Curve, in* 2 NEW PAL-

tonically increase with national income for some countries but exhibit an inverted U-shaped relationship for others.[241] To assume that in the case of, for example, China, there will someday suddenly appear a new demand for GHG reduction merely because other nations have previously discovered relatively cheap and effective ways to reduce their own GHG emissions would be to ignore the striking lesson of the present day, when Chinese conventional pollution has soared with its industrialization. Since China has largely eschewed the emission reduction technologies for conventional pollutants made available by pollution control efforts in already industrialized countries, why would one expect China to adopt at some future point the GHG reduction technologies made available by present-day GHG emission reduction requirements in such countries?

This may be overly pessimistic.[242] China, India, Brazil, and other rapidly industrializing countries may indeed someday provide a lucrative market for GHG reduction technologies—most especially carbon capture and storage—developed by virtue of unilateral U.S. GHG emission reduction requirements.[243] And there are other potential

---

GRAVE DICTIONARY OF ECONOMICS 892, 892–93 (Steven N. Durlauf & Lawrence E. Blume eds., 2d ed. 2008).

241 Elbert Dijkgraaf & Herman R.J. Vollebergh, *A Note on Testing for Environmental Kuznets Curves with Panel Data* 16–17 (Fondazione Eni Enrico Mattei Working Paper No. 63.2001, Sept. 2001), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=286692. The inconsistent relationship for CO_2 is perhaps predictable, given the more general finding in the Environmental Kuznets Curve literature that the more dispersed is the externality from a particular pollutant, the higher the turning point in national income at which levels of the pollutant begin to decline; for pollutants with the most dispersed negative impacts, there often is no turning point. *See* Levinson, *supra* note 240, at 892–93.

242 But it is unlikely. *See* Jon Hovi et al., *The Persistence of the Kyoto Protocol: Why Other Annex I Countries Move on Without the United States*, 3 GLOBAL ENVTL. POL. 1, 20–21 (2003) (analyzing an existing case of early moving on climate change policy—the European Union's early leadership in pursuing (superficially at least) a GHG reduction policy despite the failure of the United States to participate in the Kyoto Treaty—and rejecting the hypothesis that such behavior is motivated by rational strategic gain and believe that it is instead explained by the bureaucratic inertia of EU climate institutions and the desire of EU actors to strengthen the European Union as a foreign policy force).

243 For discussions of the potential for profitably transferring such technologies if they are indeed developed, see Scott Barrett, *Proposal for a New Climate Change Treaty System*, ECONOMISTS' VOICE, Oct. 2007, at 1, 4, *available at* http://www.bepress.com/cgi/viewcontent.cgi?article=1240&context=ev, and Gwyn Prins & Steve Rayner, *Time to Ditch Kyoto*, 449 NATURE 973, 974 (2007). Brian R. Copeland and M. Scott Taylor have demonstrated that international trade is likely to play a significant role in determining the impact of developed country GHG emission reductions. They show that by increasing developing country income from the production of "dirty" (that is,

justifications for unilateral action that have not been formally modeled by economists. For example, by acting unilaterally, the United States could at the very least alter somewhat the rate of change in global CO_2 emissions, and such a change in the global rate of change in CO_2 could provide more information on the actual impact of changing CO_2 stocks on the crucial regional impacts of increasing global average temperature. Further exploration of these and other possible justifications for the United States to take costly actions now to reduce GHG emissions is beyond the scope of this Article. The important and concluding point for present purposes is that none of these very complex and indirect benefits from present-day GHG reduction make GHG reduction even remotely similar in its anticipated impact to the kind of pollution reduction that Congress intended to cover under the CAA. That statute mandated federal, state, and local regulations that if effectively enforced, would be successful in reducing conventional pollutants, and improving ambient air quality, *regardless* of the present or future actions of other countries. Such effective unilateral action is at the best extremely unlikely in the case of climate change.

CONCLUSION: THE CAA DOES NOT COVER GHG EMISSIONS, BUT THIS DOES NOT MEAN THAT CLIMATE CHANGE IS NOT A PROBLEM REQUIRING A POLICY RESPONSE

It is important to understand the limits to the scope of the argument that I have made in this Article. My argument is that the distribution of short-to medium-term costs and benefits to the United States from taking costly action to reduce GHG emissions is so very different than the distribution of costs and benefits from regulating air pollutants under the CAA that it is completely unreasonable to interpret the CAA as covering GHG emissions. This argument does not imply that climate change is not a problem for the United States, nor does it imply that the United States should do nothing to reduce its GHG emissions. There is credible scientific evidence that if GHG emissions continue to increase, then in the very long run—beyond 2100—there are a variety of severe harms that might befall people in

---

GHG emitting) goods, reduction in the developed country GHG emissions could actually stimulate the demand for GHG emission reduction in the developing countries by enough to offset both the shift of dirty good production to such countries (so-called leakage) and also free-riding by such countries. Brian R. Copeland & M. Scott Taylor, *Free Trade and Global Warming*, 49 J. ENVTL. ECON. & MGMT. 205, 229–31 (2005).

the United States.[244] There is also credible scientific evidence that even in the short-to-medium term—up to 2100—many developing countries are likely to suffer harm as a result even of moderate changes in climate.[245] Hence as a matter purely of national self-interest, the United States has an interest in adopting policies designed to lessen the likelihood of harmful far-distant climate change. And for a variety of foreign policy reasons—ranging from a concern with international equity to a concern with the possible impact of climate change in developing countries in prompting mass immigration and exacerbating the international terrorist threat—the United States has an interest in taking costly action to lessen harmful near-to medium-term climate change impacts in developing countries.

The optimal U.S. response to climate change depends upon why the United States is acting: to attempt to avert short-to medium-term harm in developing countries, or instead to prevent very distant and uncertain and yet also potentially very costly harm to the United States. From the long-term point of view, clearly a program of significant government subsidies for research and development into clean coal (carbon sequestration), as well as non-carbon-based energy sources, makes sense. If and when such technologies are developed, their adoption can also be subsidized. Such a pattern of expenditure would acknowledge an obligation of the present generation to do something now—the U.S. government of today should spend far, far more than it has thus far in directly funding and indirectly rewarding

244 The economic studies of the impact of climate change cited *supra* notes 107, 121–34, for example, clearly show that temperature increases above seven degrees centigrade inflict large net losses on American agriculture.

245 Consider, for example, Africa. As the IPCC notes, climate is a "significant control on day-to-day economic development of Africa," with agriculture and water-resource sectors especially vulnerable to climate fluctuations. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 121, at 436. Under a variety of future climate scenarios, the IPCC predicts that there will be by the 2080's a "significant decrease in suitable rain-fed land extent and production potential for cereals," with an increase in arid (desert) and semi-arid land in Africa of five to eight percent and the likely disappearance of wheat production from Africa. *Id.* at 448. For an Asian example, see Jonathan T. Overpeck and Julia E. Cole, *Lessons from a Distant Monsoon*, 445 NATURE 270 (2007) (opining that if the Indian monsoon intensifies, as some climate models predict, then Indonesia in particular will have more severe and longer droughts, imperiling rural livelihoods and natural resources). Not only is developing world agriculture more susceptible to drought, increases in sea level that cause a loss of coastal agricultural land are much more damaging in poor countries that cannot as easily substitute for land loss by increasing fertilizer use and in which agriculture is a much larger share of the national economy. *See* Francesco Bosello et al., *Economy-Wide Estimates of the Implications of Climate Change: Sea Level Rise*, 37 ENVTL. & RES. ECON. 549, 557 (2006).

research and development into technologies that generate no or low CO_2 emissions—while also shifting to future generations a good share of the cost of widespread adoption of whatever technologies are developed.

There is no guarantee that such technologies will come online quickly enough, however, to help developing countries deal with adverse short-to medium-term consequences of a warming climate. But given the very long half-life of atmospheric CO_2,[246] it is far from clear that anything but an immediate and drastic decarbonization of the economy of the United States and other large CO_2 emitting countries will do anything to slow or reverse global warming in time to prevent harmful impacts on developing countries. Even with drastic decarbonization, such countries may well suffer harm from a warming climate. That is, the short-to medium-term harm from climate change is due not to current emissions, but primarily to atmospheric CO_2 that was emitted over the last thirty-five or so years, most of which will remain in the atmosphere for decades to come. Radical decarbonization—such as a wholesale conversion to nuclear power—might well drastically cut current CO_2 emissions,[247] but it will not prevent short-to medium-term harm to developing countries. Such harm can be averted only by either large-scale adaptation in such countries, or by moving people out of harm's way: that is, by large-scale immigration from hazardous developing countries to safer developed countries. The choice among these and other alternatives, and in particular the question of how much developed countries should pay to help developing countries cope with climate change, involves questions of relative efficacy, efficiency, and fairness. These issues are important, but their consideration is beyond the scope of this Article and best left to future work.

---

246 Of any given exogenous increase in CO_2 input into the atmosphere, a substantial fraction is absorbed relatively quickly by the oceans, while in the very long run of hundreds of thousands of years, only about seven percent remains. In the centuries in between, CO_2 is slowly absorbed by the oceans and biosphere. *See* David Archer, *Fate of Fossil Fuel CO_2 in Geologic Time*, J. GEOPHYSICAL RES., Sept. 2005, at C09S05, at 5. For the classic analysis, which shows the importance of the assumed rate of oceanic and biosphere absorption to the time path of atmospheric retention, see U. Siegenthaler and H. Oeschger, *Predicting Future Atmospheric Carbon Dioxide Levels*, 199 SCIENCE 388, 391–92 (1978).

247 Even many committed climate change scientist advocates end up recommending at least some conversion to nuclear power, *see, e.g.*, R.T. Pierrehumbert, *Climate Change: A Catastrophe in Slow Motion*, 6 CHI. J. INT'L. L. 1, 18 (2006) ("[S]olving the problems of nuclear power is arguably more tractable than solving the problems of burning coal safely—especially safely sequestering the highly mobile carbon dioxide that is the inevitable consequence of coal burning.").