ENVIRONMENTAL POLICY FOR THE ANTHROPOCENE:
Information, Incentives, and Effective Institutions

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In view of the uncertainty brought about by human-caused climate change, what types of institutions should we rely upon to mitigate the undesirable effects of climate change? To help answer that question, we look to the economics literature, especially work on information in markets and fiscal federalism, to see what it can tell us about the relative merits of centralized and decentralized decision-making. [1] Our main argument is that the optimal degree of centralization or decentralization will depend, in part, on (i) whether new information regarding the effects of climate change will be more easily observed at the central level or the local level and (ii) which types of institutions will be most effective in keeping the incentives of decision-makers aligned with the costs and benefits of their decisions.

Although some of the economic concepts we employ are widely recognized in the literature on climate change, others have received, in our view, far too little attention. Given the global nature of the causes and consequences of climate change, it is

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unsurprising that so much attention has been focused on efforts to reduce greenhouse gas emissions through international treaties. This makes sense because, in essence, the textbook solution to a problem of this type would be to negotiate a global level of emissions (ideally weighing all the costs and benefits), and then employ a system to achieve the desired level of global emissions in a relatively low-cost way, such as through carbon taxes and other price mechanisms. Of course, whether we will see anything even remotely resembling an enforceable agreement in the real world, let alone an agreement yielding a close-to-optimal level of emissions, remains to be seen.

Regardless of the degree to which negotiations, other policies, or individual actions succeed in reducing greenhouse gas emissions, the question of how to reduce the costs of climate change remains. And it is on this aspect of policy for the Anthropocene that we argue key ideas from public economics have received too little attention. In particular, as Mother Nature reveals more information about the effects of human activity on the climate, the question of how and when that information becomes known will influence the success or failure of different policy approaches. If new information is acquired in a dispersed manner, such as by individual landowners observing changes on their own land, a centralized decision-making system will tend to perform poorly relative to a system that allows the localized information to guide decisions. By contrast, if the new information were easily observed by experts, such as scientists, and individual landowners lacked incentives to use that information in a manner that yields good outcomes, then a more centralized system of decision-making could be preferable.[2]

To understand our argument, it is essential for the reader to recognize our starting point. Although the political rhetoric surrounding climate change has often revolved around accusations of climate change "denial" and counter-accusations of politically driven scientific reports, those issues are red herrings with respect to the concerns in our paper. If everyone came to view climate change as a serious problem, that might move us a step closer to an effective policy response, but it is far from clear that merely recognizing a serious global problem will lead to a good solution. Indeed, even when large numbers of people face imminent threats of death (in wars, for example), collective responses may fail to avoid disastrous outcomes. Thus, for any serious effort to guide policy responses to climate change, the question of what types of policies will actually work must be treated as a topic of first-order importance. And it is with this "what actually works" focus in mind that we examine the policy implications of the Anthropocene. By taking this approach, we hope that our analysis will be valuable to readers with a range of perspectives—whether optimistic or pessimistic about climate change and the role of government in society.

As a starting point for our analysis, we outline (in Section II) the standard economic explanation of why well-functioning markets are so valuable. In essence, when markets function well, market prices serve two critical roles: They provide incentives to engage in mutually beneficial exchange, and they convey otherwise unobservable knowledge about costs and benefits of activities. Closely related to that point is the standard approach to the question of which levels of government—centralized or local—will tend to deliver better public policy when markets, if left alone, fail to account for important costs and benefits.

By applying these ideas to environmental problems, we are following a path similar to those taken by many previous scholars, particularly those affiliated with PERC.[3] Most directly, we build on the nascent literature that uses lessons from law and economics to assess what types of institutions will work for the Anthropocene. Regan emphasizes the value of adaptability in the face of an ever-changing world.[4] In particular, he relates ideas from Austrian economics to ones from ecology, pointing out the importance of approaching environmental policy decisions in light of evolving economic and environmental conditions. On a similar theme, Adler calls for "adaptive management" in environmental law and policy, emphasizing the value of adaptability in response to environmental changes.[5] In earlier papers, Adler focuses on water policy, explaining the roles for property rights and markets in successful responses to climate change.[6] Huffman explains the advantages of relying on legal rules that have evolved over time, particularly those rules that define and allow the enforcement of property rights.[7] He emphasizes, as we do, the importance of Friedrich Hayek's work suggesting that a good legal system must make use of diffuse private knowledge.

CORE ECONOMIC CONCEPTS: MARKET PRICES, INCENTIVES, AND INFORMATION

Underlying the critical incentive and informational roles of market prices is the fact that prices indicate how much of one good can be voluntarily exchanged for other goods. The field of economics has, at its core, a rigorous exposition of that point.[8] For our purposes here, we will present a simple thought experiment to convey the intuition underlying the way economists view markets and prices. This will set the stage for our discussion of environmental policy for the Anthropocene.

Voluntary Exchange and Information: A Very Simple Example

Consider a teenager who works as a gardener for neighbors at a wage of $10 per hour. She has the option of forgoing leisure hours in exchange for pay, which can in turn be exchanged for other goods. To purchase a $1,200 mountain bike, the teenager

would need to forgo 120 hours of leisure. Thus, the opportunity cost of the mountain bike is 120 hours of leisure, and, symmetrically, the opportunity cost of the leisure is the mountain bike. Similarly, by purchasing an hour of the teenager's gardening services for $10, the neighbors are forgoing some other good, perhaps trading away 15 minutes of leisure if they earn $40 per hour, or perhaps forgoing a restaurant meal that would cost $10 more than eating at home.

The incentive role here is quite obvious: The ability to trade goods and labor at market prices provides incentives to engage voluntarily in mutually beneficial exchange. The most famous comment on this point is from Adam Smith's *Wealth of Nations:* "It is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner, but from their regard to their own interest."[9]

Less obvious is the essential informational role of market prices.[10] The fundamental problem with most non-market systems of allocation is that they provide, at best, little information about the opportunity costs of goods and the value of goods to consumers. Quite simply, there is no reliable way to estimate how much people value some good—such as a mountain bike, leisure, or gardening services—unless we observe how much they are willing to give up in order to have it. Moreover, if we see voluntary trades, it is usually reasonable to infer that we are observing mutual gains from exchange. People make mistakes, of course, but if we see a teenager provide 120 hours of gardening labor in exchange for money to buy a mountain bike, it is likely that the teenager preferred the mountain bike to the forgone leisure, that the buyer of the gardening labor preferred the improved garden to other forgone goods, and that the seller of the mountain bike expects that $1,200 can buy something he or she values more than the mountain bike.

The key point, of course, is not that markets work perfectly, but that in most cases knowledge problems render the alternatives worse. For example, if instead of allowing voluntary exchanges of labor and mountain bikes, we empowered a city official to conscript teenage gardeners and to allocate mountain bikes and other goods, even a well-meaning official would be destined to make mistakes. There would be no reliable way to find out who valued a bike (or $1,200 of other goods) more than 120 hours of leisure, who valued gardening services more than $1,200, and so forth. Inevitably, centrally planned allocations enforce what are, in effect, mutually undesirable exchanges and prevent desirable exchanges. And if a non-market system allocated gardening services and bikes to the politically well-connected—doing so by taking leisure and bikes from the less well-connected—that would be even worse. The principal point regarding knowledge, however, is that even a well-meaning government official would be unable to allocate goods in a sensible manner.

The real world is, of course, far more complex than our story about gardening and mountain bikes. Each of us regularly chooses among a huge number of goods and ways to spend our time. Note that even a decision to buy a mountain bike involves not just whether to buy one, but making a selection among many quality levels and styles. In this light, the knowledge problems faced by a central planner trying to allocate goods and services are insurmountable—far more so than in our simple story.

An Example of a Missing Market

As a practical matter, the success of markets in weighing costs and benefits—when they do indeed succeed—comes from getting the incentives right and making use of the price system as a mechanism to aggregate and employ otherwise dispersed private knowledge. A critical concern, then, is whether prices will, in fact, reflect opportunity costs in a sufficiently accurate manner. In this light, if we see an environmental problem in the sense that some type of activity is generating costs greater than the benefits, we can ask whether a price system might resolve the problem.

A classic example is that of a common pool resource with unrestricted access. To illustrate the problem, consider a lake surrounded by residents who use the lake for fishing. If each individual chooses how much to fish by weighing only his or her costs (e.g., time) and benefits (fish caught), the stock of fish may be rapidly depleted, leaving all the residents worse off than if they agreed to reduce their catch. The fundamental problem can be viewed as a "missing market" in the sense that taking a fish out of the lake has an opportunity cost: Neither the fish nor its potential offspring can be caught in the future. This opportunity cost is incorporated only incompletely (or not at all) into individuals' fishing decisions. Thus, in the absence of some kind of agreement or restriction on fishing, individuals decide to fish "too much" relative to what they would do if they reached a mutually beneficial agreement.[11] Note that one potential solution would be to collect a fee for every fish caught: With an appropriately set fee, the problem of a missing market, and hence the problem of overfishing, would be eliminated.

Once again, consider the central factor in our discussion: the role of information. An extreme case would be a perfectly informed benevolent official. With perfect information about every individual's benefits and costs, the official could simply assign fishing quotas (as individual-specific allotments) so that each resident would catch fish until the point where the next fish caught would be worth more in the lake than if caught. With more than a trivial number of resident-fishers involved, the task of obtaining such information, other than through a market, would be prohibitively

difficult. Yet a more market-oriented solution can be implemented with much less information. Even if no single individual knows much about any other individual's costs or benefits, setting a total number of fish caught, (known as a "total allowable catch," and allocating tradable rights to catch those fish may generate something close to what a perfectly functioning market would yield.[12]

The key point is that the market price of the tradable right to catch a fish implies that each individual catching a fish incurs an opportunity cost—either buying the right to catch the fish or forgoing the opportunity to sell the right to someone else. If the total allowable catch is set appropriately, with the price of fishing rights set by supply and demand, the outcome will match the ideal market case because the otherwise missing market is no longer missing. Crucially, there is no need for any official to ascertain the benefits and costs to each individual, because each individual will buy or sell the fishing rights according to his or her own benefits and costs. Of course, the question of how to set the total allowable catch remains, but one reason for optimism relative to a top-down, command-and-control approach is that all holders of tradable rights have an incentive to oppose setting an excessively large catch (because the value of future fishing rights will fall as the stock of fish is depleted) or an excessively small catch (because the value of catching a few fish will be small). In sum, when knowledge is dispersed, market mechanisms—even if they rely on centrally created rights—have more plausibly satisfied information requirements than do command-and-control mechanisms.

INFORMATION AND THE ANTHROPOCENE

Using the ideas we set out in Section II, we will now turn to our paper's central question: As Mother Nature reveals the effects of human-caused climate change, what types of institutions will be most effective in making use of that information? A useful way to address this is to identify two types of mismatches between institutions and the nature of information, then examine the inevitable tradeoffs involved when choosing whether to make decisions in more versus less centralized ways. We will illustrate this by discussing three topics: greenhouse gas emissions, water use, and the protection of wildlife habitat.

Greenhouse Gas Emissions

Greenhouse gas emissions provide a textbook-style illustration of a case in which decentralized decision-making will fail to weigh important costs and benefits. The fundamental concern is that even if individuals could know the consequences of their actions (e.g., how driving more miles on a road trip will, at the margin, influence

environmental outcomes on barely-above-sea-level islands), it would be impossible for decentralized contracts among the affected parties (e.g., drivers in Montana, residents of islands) to contract with each other in an effective manner. Moreover, because individuals bear such a small fraction of the consequences of their own greenhouse gas emissions, there is no reason to expect that relying on individuals to weigh their own costs and benefits will suffice to approximate weighing the costs and benefits to all individuals. In this light, some central coordination can be valuable, making international agreements an obvious consideration.[13] That said, a centralized effort to determine who should reduce emissions by how much would be, at best, inefficient because information about the costs of reducing emissions is dispersed and, indeed, individual-specific. Put another way, in the absence of information obtainable only through market prices or some other type of voluntary exchange, mandated emissions reductions will in some places impose large costs for relatively small environmental gains, while in other places miss opportunities for large environmental gains at relatively low cost.

Note that regulations targeting specific aspects of goods—such as fuel economy standards for automobiles—are commonly used and can be imposed without using a market mechanism to address the problem of dispersed knowledge. Policies of this type may be effective in reducing greenhouse gas emissions. Crucially, however, such policies address the missing-market problem in, at best, an indirect manner. In the case of fuel economy standards, for example, an increase in miles per gallon must come at some cost, such as engineering costs, construction costs, safety, performance, or discomfort. Imposing these costs does not solve the fundamental problem of missing markets. Note that in the case of an individual who drives very few miles, the additional cost of a mandated "green" car will yield little reduction in emissions. Moreover, the incentives created by such policies need not align individuals' incentives with the policies' objectives. For example, increased fuel economy will, all else equal, reduce the cost per mile driven and may therefore increase miles driven and weaken incentives to carpool.[14]

In sum, the effectiveness of efforts to reduce greenhouse gas emissions will depend on two fundamental lessons from public economics. First, negotiations will likely need to be conducted at a relatively centralized level in order to "get the incentives right" in the sense of having a sufficient portion of the global costs and benefits accruing to the constituents represented by the negotiators. Second, for whatever emissions objectives are set, reaching those objectives in a sensible manner will require the use of dispersed knowledge. Therefore, we expect that price mechanisms, such as emissions taxes or tradable rights, will be necessary for

reaching any meaningful emissions objectives—otherwise, excessive costs will derail public support.

Water Use

The effects of climate change on the allocation of water can be viewed in a similar manner. For the purpose of discussion, let us assume that climate change will bring about undesirable shifts in patterns of precipitation, such as prolonged droughts. This would provide further reason to seek international agreements that reduce greenhouse gas emissions—even more so if prolonged droughts would present a national security threat.[15] Yet once the snow and rain have fallen wherever they fall, decentralized decisions are essential for reducing the harm done by droughts.[16]

Again, the potentially useful role of centralized decisions, along with the information problems created by centralized decision-making, are clear. Allocating water for environmental uses—such as leaving water in streams, lakes, and wetlands—may have such broadly distributed benefits that decentralized individual actions lead to undesirable outcomes. Put another way, the overconsumption of water by individual users may be exactly analogous to the overfishing problem discussed in Section II. Yet without a price mechanism based on voluntary exchange, the value of water for agricultural, residential, and commercial uses cannot be reliably identified: A farmer facing market prices for his or her crops generally will be able to assess how much an additional acre foot of water is worth on his or her farm, whereas bureaucrats will not. Similarly, bureaucrats who impose per-household limits on water consumption will do so without knowing which households would benefit a lot or a little from additional water.

Thus, when choosing between more versus less centralized decision-making mechanisms, the key practical question is not what would be ideal, but what is most effective. In circumstances where government officials can and will assess environmental benefits relatively well—such as knowing how much water left in a river will preserve highly valued wetlands downstream—a centralized decision regarding the quantity left in the river, combined with tradable water rights and price mechanisms, may work well. And, if climate change brings about major shifts in precipitation patterns, such as severe droughts combined with intensified El Niño effects, there will be more at stake in the quality of centralized decisions (for which scientific expertise is essential) and from allowing market mechanisms that make use of dispersed knowledge. Put another way, the potential harm from allowing unrestricted water use will likely become greater as a result of climate change, and so will the potential harm from restricting market-based trade in water.

Wildlife Habitat

As a starting point, consider the following scenario, which we intend to be a useful abstraction rather than a description of the real world. Suppose that the current habitat of some type of charismatic megafauna (e.g., sea lion, whale, lion, elephant, bear) will become too warm or otherwise unsuitable for that species. Also suppose that having the species in the wild provides great value to humans, so that the relevant policy question is not whether to allow the species to relocate, but rather how to set policy that allows the species to make a successful move. Once again, the degree to which we should expect centralized or decentralized decision-making to prove effective will depend on how Mother Nature reveals information—and on the extent to which making good use of that information depends on inherently private knowledge.

For the case of, say, protecting easily tracked, endangered marine mammals that migrate long distances, relying on "command-and-control" style policies could be effective. The better the ability of experts to observe the animals' locations and health status, and the less informed the general public, the more potential benefits there would be from issuing regulations centrally—perhaps along the lines of a national agency issuing orders to restrict fishing or boating in specific locations as the endangered mammals migrate. Moreover, if a changing climate reduces the degree to which past migration paths and timing can predict future paths and timing, that would imply more reason to rely on centrally observed scientific information, and less on local knowledge. Similarly, the more easily the government can enforce restrictions on the types of boats and fishing practices that might harm the migrating mammals, the more effective will be those restrictions.

Yet the example just described may be far from the norm, because much of the information about wildlife habitat, and about the opportunity cost of keeping habitat suitable for wildlife, will be dispersed. One reason is that local landowners are typically the best positioned to observe their land. Serious problems arise for centralized "command and control" approaches to wildlife protection when (i) local landowners know much more about local conditions than do those setting or enforcing the policies and (ii) the existence of protected species on private land (when known to authorities) may activate legal restrictions on land use. This can lead to clandestine killing of legally protected wildlife, and it encourages landowners to engage in preemptive destruction of habitat before protected species arrive.[17] As climate change brings about shifts in where specific flora and fauna will thrive, the scope for preemptive habitat destruction will increase.[18]

Given the importance of dispersed information about wildlife and its habitat, any serious response to climate change will need to include policies that make use of that information. To see how this may work, consider the case of wildlife—such as elephants, lions, and leopards—that can be dangerous or destructive.[19] People who suffer the risk (e.g., damage to crops, lost livestock, physical harm) of living in proximity to these animals may, for good reason, see the animals as undesirable. This presents a problem for command-and-control policies, such as simple prohibitions on hunting. One reason why poachers so often succeed is that the local population has little reason to report poachers, much less keep a watchful eye on the wildlife. Yet if property rights and contracts can be established in a manner so that the costs to local residents are more than offset by the gains, such as income from tourism and hunting licenses, the locally observed information (e.g., activities of poachers) will more likely be used in a manner that protects the wildlife. In short, in recognition of the Anthropocene, policymakers seeking to protect wildlife, especially wildlife displaced from their historical habitat, should look for decentralized market solutions to habitat protection problems.[20]

Choices Within a Federal System

Before concluding, we discuss briefly how our main point relates to a federal system of government. One of the fundamental strengths of a federal system is flexibility with respect to the level of decision-making. Perhaps most obviously, by providing public goods through the federal branch, notably national defense, the scope for free-rider problems, which can lead to the under-provision of public goods, will be minimized. Of course, even in the case of national defense, there are still incentive and information problems.[21] Nevertheless, the broader the sharing of the benefits, all else equal, the more reason to make decisions at the federal level. And when dispersed information renders centralized decisions highly problematic, a federal system allows state and local decision-making. In short, the level of government that will perform best on a given policy depends on (i) the level at which decisions best weigh costs and benefits , and (ii) the extent to which decentralized decisions make better use of dispersed information.[22]

The performance of state versus federal management of forests provides a useful example. The evidence shows that state forests perform better on many dimensions.[23] It could be that state-level management ignores some benefits, because forests in one state, say, Montana, provide benefits to those who reside outside the state. But the consequences of that are likely minor—it is unclear why non-Montanans would want Montana forests to be managed in a far different manner than Montanans would.

By contrast, the problems with federal management will likely be large, because the "owners" (i.e., all Americans) will have little information or incentive to obtain information about what is happening on federal forests in Montana. Thus, it is unsurprising that, in practice, state-level management yields more benefits.

What might the Anthropocene imply for decisions within a federal system? At this point, we can only speculate, but it seems plausible that rearrangements both toward and away from centralization might be beneficial. On the one hand, an obvious point is that greenhouse gases have a much broader geographical effect than do the types of pollution that have had historical importance. Thus, local decisions—such as those using common law to adjudicate disputes between neighbors—will be ineffective for the control of such emissions. This increases the scope for useful federal decision-making. On the other hand, federal policies regarding land use and habitat may become ineffective or even counterproductive. For example, if climate change drives wildlife off a historical range on federal land or has a similar effect on vegetation, policies that rely on local knowledge will probably be essential for successful management. And this provides a reason to rely more on state and local governments—and on contracts between private parties.

CONCLUSION

Although no one knows precisely what the effects of human-caused climate change will be, we can nevertheless look to public economics for guidance. An obvious point is that the effectiveness of environmental policy in the Anthropocene will depend on how well institutions set policies that account for costs and benefits that accrue on a global scale, and this leads naturally to a focus on international agreements. Yet as Mother Nature reveals more information about the effects of human activity on the environment, much of that information will be revealed in a dispersed manner. And this calls for policies and institutions—notably those that support voluntary exchange and rely on market prices—that utilize dispersed new information and private knowledge.

ENDNOTES

1 See, e.g., Hayek, Friedrich A. 1945. "The Use of Knowledge in Society." *American Economic Review* 35:519-530; Oates, Wallace E. 1999. "An Essay on Fiscal Federalism." *Journal of Economic Literature.* 37:1120-49.

2 We focus our discussion on new information because so much remains unknown about the effects of human activity on the future environment. Note, however, that the issue of dispersed information being difficult or impossible to observe is not limited to new information. Indeed, much of what individuals (e.g., landowners) already know, and will eventually know, about the value of resources (e.g., alternative uses of their land and labor) will be diffuse private knowledge that cannot be unobserved centrally—price systems will, at best, serve as surrogates for that knowledge. On the "knowledge problem" and, in particular, the value of distinguishing between information and various types of knowledge, see Kiesling, Lynne. 2015. "Knowledge Problem." In Peter Boettke and Christopher Coyne, eds., *Oxford Handbook on Austrian Economics.* Oxford: Oxford University Press.

3 See, e.g., Anderson, Terry L. and Gary D. Libecap. 2014. *Environmental Markets: A Property Rights Approach.* Cambridge University Press.

4 Regan, Shawn E. 2015. "Austrian Ecology: Reconciling Dynamic Economics and Ecology." *Journal of Law, Economics, & Policy* 11:203-228; see also Regan, Shawn. 2016, this volume.

5 Adler, Jonathan H. 2016, this volume.

6 Adler, Jonathan H. 2008. "Water Marketing as an Adaptive Response to the Threat of Climate Change." *Hamline Law Review* 31:730; Adler, Jonathan H. 2012. "Water Rights, Markets, and Changing Ecological Conditions." *Environmental Law.* 42.

7 Huffman, James L. 2015. "People Made Law: Spontaneous Order, Change and the Common Law." *Journal of Law, Economics & Policy.* 11(2):179-202.

8 See, e.g., Debreu, Gérard. 1959. *Theory of Value: An Axiomatic Analysis of Economic Equilibrium.* New Haven: Yale University Press.

9 Adam Smith. 1776. *An Inquiry into the Nature and Causes of the Wealth of Nations.*

10 Hayek, Friedrich A. 1945. "The Use of Knowledge in Society." *American Economic Review*. 35:519-530.

11 The economic analysis here is related to the "tragedy of the commons" idea popularized by Garrett Hardin (Hardin, Garrett. 1968. "The Tragedy of the Commons." *Science.* 162:1243-1248), though Hardin's analysis strays from economic logic in critical ways. For good textbook discussions of efficient markets, market failures, and the classic work of Coase (Coase, Ronald H. 1960. "The Problem of Social Cost." *Journal of Law and Economics* 3:1-44), see, e.g., Landsburg, Steven E. 2005. *Price Theory & Applications,* 6e. Mason, OH: Thomson; or Rosen, Harvey S. 2005. *Public Finance,* 7th edition. Boston: McGraw-Hill. .

12 On the economics of establishing catch limits and creating property rights to marine assets, see, e.g., Costello, Christopher, Steven D. Gaines, and John Lynham. 2008. "Can Catch Shares Prevent Fisheries Collapse? *Science.* 321:1678-1681; and Deacon, Robert T. 2009. "Creating Marine Assets: Property Rights in Ocean Fisheries." *PERC Policy Series* PS-43.

13 This is not to say that international agreements will lead to good outcomes. Several factors suggest they will not, including information problems. First, no one knows the precise relationship between greenhouse gas emissions and climate change. Second, negotiators will not know the costs of reducing emissions—because those costs depend on dispersed information regarding individual-specific costs of what will be forgone in order to reduce emissions—say, by driving fewer miles in less comfortable (and/or more expensive) cars, living in smaller (and/or more expensively insulated) houses at less comfortable temperatures, etc. Third, historical experience shows that, even when the stakes are huge (as when negotiating to avoid or end warfare), efforts to negotiate may fail to avoid disasters. Thus, it is far from clear that international agreements will yield good outcomes.

14 On the economics of fuel economy mandates, see, e.g., Crandall, Robert W., and John D. Graham. 1989. "The Effect of Fuel Economy Standards on Automobile Safety." *Journal of Law and Economics.* 32:97-118; Austin, David, and Terry Dinan. 2005. "Clearing the Air: The Costs and Consequences of Higher CAFE Standards and Increased Gasoline Taxes." *Journal of Environmental Economics and Management.* 50:562-582.

15 Note that the idea of climate change, and in particular its effects on drought, creating a national security threat has received serious attention in the political arena. See, for example, CBS News. 2015. "Democratic debate transcript: Clinton, Sanders, O'Malley in Iowa." Available at http://www.cbsnews.com/news/democratic-debate-transcript-clinton-sanders-omalley-in-iowa/. Of course, such a view, if justified, indicates the absence of well-functioning markets: With secure property rights and good market mechanisms in place, droughts would lead to trade (thus reducing the harm done by the drought) rather than to warfare. This is not to suggest that setting up well-functioning markets in war zones or in otherwise failed states is feasible; indeed, our own research provides reason for pessimism. See, e.g., Fleck, Robert K., and F. Andrew Hanssen. 2013. "How Tyranny Paved the Way to Democracy: The Democratic Transition in Ancient Greece." *Journal of Law and Economics.* 56:389-416; Fleck, Robert K., and F. Andrew Hanssen. 2015. "The Foundations of Wealth-Enhancing Democracy: Aristotle, Lindahl, and Institutional Design in Ancient Greece." Working Paper, Clemson University. It is nevertheless worth remembering that whether or not scarcity leads to conflict is a function of institutions.

16 The potential gains from water markets are widely discussed in the economics literature, as is the environmental harm done by removing too much water from rivers, lakes, and groundwater sources; see, e.g., Glennon, Robert Jerome. 2002. *Water Follies: Groundwater Pumping and the Fate of America's Fresh Waters.* Washington, DC: Island Press; Scarborough, Brandon. 2010. "Environmental Water Markets: Restoring Streams Through Trade." *PERC Policy Series.* PS-46; and Libecap, Gary D. 2005. "Rescuing Water Markets: Lessons from Owens Valley." *PERC Policy Series.* PS-33. As we mentioned earlier, Adler examines the role for water markets in adaptive responses to climate change. Adler, Jonathan H. 2008. "Water Marketing as an Adaptive Response to the Threat of Climate Change." *Hamline Law Review.* 31:730; Adler, Jonathan H. 2012. "Water Rights, Markets, and Changing Ecological Conditions." *Environmental Law.* 42. Although a greater reliance on water markets has long had substantial support among economists, policymakers have often shown resistance to markets and, more generally, to price-based allocation systems. Nevertheless, the potential for using markets to mitigate the harm from climate change has been recognized by international organizations, including the United Nation's Intergovernmental Panel on Climate Change.

17 Lueck, Dean, and Jeffrey A. Michael. 2003. "Preemptive Habitat Destruction under the Endangered Species Act." *Journal of Law & Economics.* 46:27-60.

18 To understand why we expect this to be a major concern, it is important to recognize that the obstacles to monitoring from a distance what happens on land are severe. Indeed, one of the quintessential examples (perhaps the quintessential example) of private enterprise outperforming state-owned firms is the dominance of private farms, particularly family farms, over collective farms (e.g., Allen, Douglas W., and Dean Lueck. 2003. *The Nature of the Farm: Contracts, Risk and Organization in Agriculture.* Cambridge: MIT Press). The reason is that families working their own farms are, as a general rule, the best informed regarding their efforts and the output generated by their efforts. Setting up collective farms, and in doing so failing to recognize the importance of Hayek's critique, was sometimes catastrophic (e.g., Li, Wei, and Dennis Tao Yang. 2005. "The Great Leap Forward: Anatomy of a Central Planning Disaster." *Journal of Political Economy.* 113:840-877).

19 We are drawing on a substantial literature here. For a recent discussion, see, e.g., 't Sas-Rolfes, Michael, and Timothy Fitzgerald. 2013. "Can a Legal Horn Trade Save Rhinos?" PERC Working Paper.

20 Much of our focus in this paper is on the scope for useful government policy. We chose this focus because international agreements and nationwide policies tend to be the starting points for discussions of climate change. In practice, many potential environmental problems have been addressed successfully using informal agreements and private contracts. See, e.g., Anderson, Terry L. 1995. *Sovereign Nations or Reservations? An Economic History of American Indians.* San Francisco: Pacific Research Institute; Ostrom, Elinor. 2010. "Beyond Markets and States: Polycentric Governance of Complex Economic Systems." *American Economic Review.* 100:1–33.

21 An example is politicians opposed to closing home-district military bases with minimal value for national security; see, e.g., Defense Base Closure and Realignment Commission. 2005. "Report."

22 For a relevant review of the literature on fiscal federalism, see Oates, Wallace E. 1999. "An Essay on Fiscal Federalism." *Journal of Economic Literature.* 37:1120-49. For a review of the empirical literature on environmental federalism, see Millimet, Daniel L. 2014. "Environmental Federalism: A Survey of the Empirical Literature." *Case Western Reserve Law Review.* 64:1669-1757. To the extent that different jurisdictions learn from each other and/or compete with each other on the basis of public policy, there may be additional benefits from decentralization (e.g., Tiebout, Charles. 1956. "A Pure Theory of Local Expenditures." *Journal of Political Economy.* 64:416–24; Oates, Wallace E., and Robert M. Schwab. 1988. "Economic Competition Among Jurisdictions: Efficiency Enhancing or Distortion Inducing?" *Journal of Public Economics.* 35:333-54; Fleck, Robert K., and F. Andrew Hanssen. 2007. "Do Profits Promote Pollution? The Myth of the Environmental Race to the Bottom." *PERC Policy Series.* PS-41; Fleck, Robert K., and F. Andrew Hanssen. 2013. "When Voice Fails: Potential Exit as a Constraint on Government Quality." *International Review of Law and Economics.* 35:26-41).

23 Leal, Donald R. 1995. "Turning a Profit on Public Forests." *PERC Policy Series,* PS-4; Fretwell, Holly, and Shawn Regan. 2015. "Divided Lands: State vs. Federal Management in the West." *PERC Public Lands Report.*