

A Reconsideration of Environmental Federalism

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Abstract

This paper provides a review and assessment of the debate over environmental federalism—the issue of the roles of different levels of government in environmental management. The paper begins with the presentation of three benchmark cases that provide a framework for thinking about the issue. It then offers a review, first of the theoretical literature and second of some new, provocative empirical literature on the race to the bottom. The paper contends that there remains, under certain circumstances, an important role for decentralized government in the setting of environmental standards and the design of regulatory programs. The central government, in addition to setting standards for “national” pollutants, has a fundamental contribution to make in supporting research in environmental science and pollution control technology and in providing needed information and guidance to state and local governments.

Key Words: environmental federalism, environmental management, environmental policy, environmental regulation

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Environmental policymaking typically takes place in the context of a system with several levels of government. And this raises the important issue of the appropriate role of the various governments in the setting of environmental standards, the design of regulatory measures to attain the standards, and the monitoring and enforcement of these measures. Actual practice reveals a rather strange and inconsistent amalgam of decisionmaking structures. In the United States, for example, we find that the setting of environmental standards themselves manifests some striking anomalies. Under the Clean Air Act Amendments of 1970, still the cornerstone of U.S. policy for air quality management, the U.S. Environmental Protection Agency (EPA) was directed to set standards for ambient air quality in terms of maximum permissible concentrations of pollutants applicable to every place in nation. But only two years later, under the 1972 amendments to the Clean Water Act, the U.S. Congress directed the states to set standards for water quality within their own boundaries. It is not at all clear why standards for air quality should be set at a national level, while water quality standards are a matter for the states.

Likewise, in the European Union, there is a continuing tension between the principle of subsidiarity, which establishes a basic commitment to decentralized policymaking (where it is within the capacity of member states and their jurisdictional authorities) and the sense on the part of some that Europe-wide standards for environmental quality are needed.¹

In this paper, I will review the issue of environmental federalism with a focus on the setting of standards for ambient environmental quality. It is commonplace for environmental measures to take the form of centrally determined standards, with the responsibility for

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¹More precisely, the Maastricht Treaty for European Union states that action at the community-wide level is justified “only and insofar as the objectives of the proposed action cannot be sufficiently achieved by the Member States and can therefore, by reason of the scale or effects of the proposed action, be better achieved by the Community” (EC Treaty 1992, Article 36). For an excellent collection of papers on environmental decisionmaking in a federal system that draws on both U.S. and European experiences, see Braden et al. (1996).

implementation lodged with state or provincial governments. Environmental policy is thus often a joint activity. But the fundamental decision is just how stringent environmental measures are to be: meaningful decentralization thus entails local control over the stringency of the standards for ambient environmental quality.²

In the first section of the paper, I approach this issue at the conceptual level by setting forth three benchmark models of environmental circumstances. I find this helpful in thinking about where in the hierarchy of government the standard-setting function should be placed. After a preliminary consideration of the benchmark cases, the paper examines in more depth the so-called race to the bottom that has motivated sentiment in favor of the centralization of environmental management. The latter part of the paper offers a survey of the empirical work on this matter and summarizes recent studies that provide valuable insights. In the final section, I offer some reflections on all this for the structure of environmental decisionmaking.

1. Thinking about Environmental Federalism: Three Benchmark Cases

For purposes of the analysis, let us envision a system with two levels of government: a central government that may set ambient environmental standards to be met in each of the jurisdictions that make up the whole nation. At the lower level are local governments that make policies for their own constituencies. In this setting, we consider three kinds of pollutants.

Benchmark Case 1: Pure Public Good

The first case is one where environmental quality is a pure public good for the nation as a whole. It is important to understand just what this means. It does not mean that everyone, irrespective of his or her location, necessarily experiences the same level of environmental quality. Under global warming, for example, the predicted effects involve dramatic regional differentials. What I have in mind can rather be expressed as

$$Q_i = f(E) \tag{1}$$

²The term *standard* is somewhat ambiguous. It can refer, for example, to an emissions standard—that is, a limit on the emissions of a particular source or set of sources (sometimes called a performance standard)—or a technology standard that requires the use of a specified pollution control technology. My focus here, however, is on an ambient standard: a standard for environmental quality (such as the allowable concentration of a pollutant in the atmosphere) that must be met through some kind of system of pollution control.

where Q_i is understood to be a *vector* of environmental quality, whose elements indicate pollutant concentrations at each of n places in the nation. I will associate place i with the i th local jurisdiction. Thus, environmental quality in general varies across the locations, but it is a function of the aggregate level of emissions, E , where E is the sum of the emissions from all sources in the nation. The critical property of this case is that a unit of polluting emissions has the same effect on the vector of national environmental quality regardless of where it takes place; a unit of emissions in jurisdiction i is a perfect substitute in this sense for a unit of emissions in jurisdiction j .

In such a setting, it seems clear that central determination of environmental standards is in order. Decentralized, local jurisdictions simply do not have control over the level of environmental quality within their own boundaries, since Q_i , the level of environmental quality in the i th jurisdiction, depends on the aggregate level of emissions, E . Moreover, emissions in any given jurisdiction spill over and degrade the environment in other jurisdictions, so there exists a standard sort of interjurisdictional externality.

There is consequently a need for the central government to set standards. On efficiency grounds, the central environmental authority should set a standard for environmental quality that satisfies the basic Samuelson condition: one for which the marginal benefits (i.e., benefits from a unit of improvement in environmental quality summed over everyone in the nation) equal marginal abatement cost. Efficiency would further require some kind of program (such as a national uniform effluent charge or a nationwide system of tradable emissions permits) that results in an equating nationwide of marginal abatement costs across sources.

In fact, our first benchmark case is not widely applicable. But two important cases come to mind—both involving global environmental problems: global climate change and depletion of the ozone layer. For these matters, environmental degradation is, in the sense I have used it, a global public good. A unit of CO_2 emissions or chlorofluorocarbon emissions has the same effect on global environmental quality irrespective of its location. And as is universally recognized, these problems require a global solution.

Benchmark Case 2: Local Public Good

The second prototypical case is one for which environmental quality is a purely local public good. By this, I mean that polluting waste emissions within a given local jurisdiction have their effects solely within that jurisdiction. In more formal terms, we have

$$Q_i = g(e_i) \tag{2}$$

and thus the level of environmental quality in the i th jurisdiction, Q_i , depends only upon the level of waste emissions, e_i , in that jurisdiction. There are some instances in the real world that seem at least to approximate this case. For example, the quality of local drinking water and the collection and disposal of local refuse, with some minor qualifications, involve such circumstances.

For this case, the efficient level of environmental quality is that for which the sum of the benefits from reduced waste emissions (summed over the residents of the jurisdiction) equals marginal abatement costs. This, on the face of it, calls for a decentralized determination of environmental quality, with each jurisdiction setting its appropriate standard for environmental quality. The efficient outcome here will, in general, involve differing levels of environmental quality across localities. For Benchmark Case 2, assuming that local governments seek to maximize the welfare of their residents, we thus envision a system of decentralized standard setting and environmental management. This is the case where the principle of subsidiarity appears directly applicable.³

However, this may be too simplistic. I will return to this case in the next section to take up a forceful objection that has been raised in the literature; it suggests the presence of a race to the bottom in a setting of decentralized environmental decisionmaking, even for the case of a pure local public good.

Benchmark Case 3: Local Spillover Effects

The third case is the most common in practice. Here the effects of local waste entail both local pollution and some external effects on other (most likely neighboring) jurisdictions. We thus have

$$Q_i = h(e_1, e_2, \dots, e_n) \quad (3)$$

in which the level of environmental quality in jurisdiction i depends on the particular pattern of emissions in all n localities. There are numerous instances of both air and water pollution where

³The case for the decentralized provision of local public goods has been formalized in terms of the so-called Decentralization Theorem (Oates 1972, chapter 2). In the treatment of this proposition, we find that the magnitude of the gains from decentralization (compared with a uniform level of output across all jurisdictions) depends on the price elasticity of demand and on differences in costs across jurisdictions (Oates 1997). In light of this, it may be useful to explore whatever information we have on the price elasticity of demand and on differentials in costs for various forms of environmental quality to get some sense of the potential welfare gains from the decentralization of environmental management. For a valuable study of this kind, see Dinan et al. (1999) on drinking water contamination, discussed in section 4 of this paper.

polluting activities in one jurisdiction flow across boundaries (sometimes over long distances, as with acid rain).

As is widely recognized, such interjurisdictional externalities are likely to be the source of distorted outcomes, typically involving excessive pollution, in a setting of decentralized decisionmaking. Our natural response for this case is to invoke central intervention of some kind (although there may well be instances where Coasian-type negotiations can lead to an efficient resolution of the problem). Let me simply note here that the precise form of such central intervention is not entirely clear. But one thing is clear: the efficient outcome will *not* in general take the form of uniform national standards for environmental quality. The efficient pattern of pollution control will generally imply differing levels of environmental quality across jurisdictions.

The economist's usual response to such externalities is to prescribe a set of emissions taxes that internalize the social damages. But in an intergovernmental setting, this solution is less practical. The central government must either specify some set of differentiated taxes directly on polluting sources across the nation, or offer an appropriate and differentiated subsidy to local governments to induce them to internalize the interjurisdictional benefits from pollution control. I will return to this issue in a later section. My point here is simply that this is both a common case in practice and a complicated one in principle for environmental federalism.

2. The Issue of a Race to the Bottom

In this section, I want to reexamine Benchmark Case 2, our case of a local public good. This is the primary and strongest candidate for the decentralized setting of environmental standards. But there is a large literature addressing both local public finance and environmental regulation that argues that even for this case, decentralized decisionmaking is not appropriate—that it results in distorted outcomes that typically exhibit suboptimal outputs of local public goods or, in our case, excessive levels of local pollution.

The basic contention in this literature is that in a setting of interjurisdictional economic competition, local officials, in their eagerness to attract new business investment and create new jobs, will introduce measures to reduce costs to local business in the form of low taxes and excessively lax environmental standards, which will result in suboptimal outputs of local public goods (including environmental quality). In one sense, the argument is puzzling. If local governments seek to promote the well-being of their residents, then they should care about local environmental quality. If the benefits from a marginal improvement in the local environment

exceed the costs, we should expect the improvement to receive support and be carried out. What is going on here?

There is now a large—in fact an enormous—theoretical literature on all this.⁴ Let me first point out that it is straightforward to construct a standard kind of model of local public decisionmaking in which competition among governments induces efficient local choices (e.g., Oates and Schwab 1988; Wellisch 2000). In these models, jurisdictions compete for mobile firms to increase local wage income and expand the local tax base. The models generate what are effectively analogues to the purely competitive model for the private sector; they provide invisible-hand theorems in which interjurisdictional competition guides local public choice into Pareto-efficient outcomes.

In these models, governments that are small (in the sense of being price takers in a national capital market) compete for a national stock of capital, making use of a rich array of policy instruments: they provide public inputs that raise the productivity of local private capital; they provide public services for residents; they set environmental standards with associated measures to restrict the emissions of polluting firms; and they levy taxes on both local firms and residents. In the appendix to this paper, I draw on a series of earlier papers by Schwab and me to pull together just such a model and show how it produces efficient outcomes for both private sector activities and the local public economy (including local environmental quality).

But these models are restrictive. They not only assume that local governments are small in national capital markets; they also assume that these governments do not behave strategically with respect to their neighbors. In addition, the models postulate that local officials have the full range of needed tax and regulatory instruments to engage effectively in benefit taxation by taxing both residents for the public services they receive *and* firms for the public inputs they make use of. Not surprisingly, when we amend these conditions in various, often quite realistic, ways, the efficiency properties of their outcomes may no longer hold.

⁴As I indicated, this literature extends beyond the issue of environmental federalism to the more general matter of decentralized public finance. On the broader issue of interjurisdictional economic competition, Wellisch (2000) has recently provided a superb, systematic, and comprehensive treatment of the theoretical literature. Wilson (1999) has also given us an excellent explication and survey of tax competition. On the more specific theoretical issue of decentralized environmental decisionmaking in a setting of economic competition, see again Wilson (1996) for a valuable review. There is, in addition, a very rich and illuminating literature on the race-to-the-bottom issue in the law journals. For some excellent contributions from legal scholars, see, for example, Revesz (1992, 1996), Esty (1996), Engel (1997), and the collection of essays edited by Esty and Geradin (2001).

An important point of departure in this literature has been a series of models in which the local government has restricted access to tax instruments, so it cannot engage solely in benefit taxation. In the simplest case, such models assume that local governments can tax only mobile capital and that all public services (those for residents as well as local firms) must be financed by a tax on capital. In this framework, the seminal papers by Zodrow and Mieszkowski (1986), Wilson (1986), and Wildasin (1989) show that such nonbenefit taxation of capital by local governments leads not only to a regional misallocation of capital but also to distorted local public finance. In particular, there arises a kind of fiscal externality. From the perspective of an individual locality, the cost of providing public services entails the resource cost plus the loss of tax base to other jurisdictions that accompanies the raising of local tax rates. And this typically leads, at least in the most basic models, to suboptimal levels of local public services.

A corollary to this result is one for local environmental policy. Since more stringent environmental measures raise costs to firms and deflect capital elsewhere, there is an incentive for local governments to choose excessively lax standards for local environmental quality (e.g., Oates and Schwab 1988; Wilson 1996). As Schwab and I have put it, environmental decisions in this setting have fiscal effects that induce distorted local choices on pollution control.

Such inefficient outcomes can also emerge in certain cases where jurisdictions are not small and where they engage in strategic interactions with their neighbors. Making use of game-theoretic techniques, a number of papers explore how strategic behavior, aimed at gaining an economic advantage over rivals, can make use of excessively lax environmental measures as a competitive instrument. In some cases, the introduction of harmonizing measures can promise welfare gains relative to the uncoordinated equilibria. There is typically some kind of trade-off here between the gains from coordination and the losses from more uniform levels of environmental quality across the jurisdictions. List and Mason (forthcoming) have explored such a case, making use of a dynamic game-theoretic model with asymmetric players to characterize outcomes in a setting with transboundary pollutants. In particular, they examine two subefficient policy alternatives: decentralized standard setting and a centrally determined uniform standard. Their numerical simulations of the model indicate that the decentralized setting of standards can dominate a centrally determined uniform standard if there are significant differences across the

jurisdictions and if initial levels of pollution are not too high. Otherwise, central setting of standards yields a better outcome.⁵

This is a very large and complicated literature to which I have not begun to do justice in this admittedly terse summary. It treats a wide variety of quite realistic fiscal and regulatory institutions that can produce distorted outcomes in the presence of interjurisdictional competition. These include cases of multiple tax instruments, expenditure competition, and the explicit bidding for mobile firms. For a more systematic and comprehensive treatment of all this, let me again refer the reader to the excellent surveys by two leading contributors, Wellisch (2000) and Wilson (1996, 1999).

The point here is that once we depart from the competitive case, the theoretical models typically produce distorted outcomes that involve overly lax local environmental policies. And from these models emerges the case—on theoretical grounds—for a race to the bottom that takes the form of suboptimal provision of local public goods, one of which is environmental quality.⁶

The theoretical literature is, in my view, inconclusive on this issue. One can admittedly find support for the widely heard contention that local government cannot be entrusted with the responsibility for setting environmental standards because it will sacrifice the environment on the altar of economic development. But other parts of the literature reveal some efficiency-enhancing properties of such economic competition.

Let me offer two thoughts on this. First, the really important issue here is the *magnitude* of any distortions that result from interjurisdictional competition. If the deviations from efficient outcomes are small, then the race to the bottom may be very short and inconsequential. On this issue, we have scant evidence. But there are some tangential findings that I shall review later in the paper. The problem here is that measuring the welfare losses from interjurisdictional economic competition is a formidable task. There is plenty of evidence suggesting that economic competition across states and localities is widespread and often intense (e.g., Bartik 1991). But this doesn't really address the question. Under some circumstances, such competition may be efficiency enhancing; in other settings, it can lead to distorted outcomes. Thus, the finding that

⁵ Ulph (1990), with a collection of his own important papers on this issue, provides an excellent treatment of another strand of this literature.

⁶ This is not universally the case. In fact, there are some cases where market power for local governments may actually reduce the extent of distortions from interjurisdictional competition (Hoyt 1991).

such competition exists simply doesn't tell us much about the existence or the magnitude of the race to the bottom (Courant 1994). We are badly in need of empirical estimates of these distortions.

Second, suppose that there are some tendencies toward distorted outcomes, perhaps in the form of lax local environmental standards. What is the alternative? Standard economic theory would prescribe some sort of grant or subsidy from the central government to local governments to induce them to adopt more stringent environmental standards—and these subsidies would presumably vary across jurisdictions (Wildasin 1989). But such a system of subsidies in practice seems remote. A more likely result is direct central intervention in the form of standards for environmental quality—most likely uniform standards (or at least a floor on environmental quality) on a nationwide scale. And this is clearly not an efficient, first-best outcome. In addressing this general issue, Farber (1997), a legal scholar, contends that even if decentralized decisionmaking involves significant distortions, it is far from clear whether centralized measures will, in fact, improve matters. As Farber discusses at some length, the legal history of such measures, both in the United States and in the international arena, is at best mixed. So if there is a race to the bottom, we are left with a choice between two alternatives: suboptimal local decisions on environmental quality or inefficient uniform national standards. And which of these two leads to a higher level of social welfare is, in principle, unclear. Empirical studies of the alternative regimes are needed to shed light on this issue.

Finally, let me take up a related concern that arises in an intertemporal context. Some have alleged that centralized control is required because local decisionmaking tends to be myopic and fails to incorporate the interests of future generations. The argument here is that especially in the highly mobile modern world, current residents have a limited concern with the future quality of the local environment. Not only may they move elsewhere, but it is probable that their children will end up residing in some other jurisdiction. In consequence, local residents are likely to undervalue measures that promise to protect or enhance the local environment in the more distant future. In contrast, centralized decisions (so the argument goes) will tend to internalize such concerns for the future; they will better preserve the environment for future generations.

In one very fundamental way, however, this contention is quite misleading. There is, in fact, a powerful market force that internalizes future benefits and costs in a decentralized setting: capitalization. So long as the future costs and benefits of environmental measures are known, future damages associated with current decisions will manifest themselves in *current* property values. Thus, the present residents of a jurisdiction are effectively forced into taking into account

the impact of their current decisions on the future state of the local environment.⁷ Central decisionmakers do not face such a disciplining force; thus, it is conceivable that certain classes of local decisions may better safeguard the interests of future generations than more centralized management.

3. Some Further Thoughts on the Case of Local Spillover Effects

The case where polluting activities affect environmental quality in neighboring jurisdictions presents, as we have seen, a complicated challenge *in practice* for environmental management. Policymakers in one jurisdiction often have little incentive to worry about the costs that their actions impose on their neighbors. One form of policy response to this case is centralization. As we noted, the first-best policy measure in such a case is an effluent charge per unit of waste emissions equal to the marginal external damages. But this, in general, would be a differentiated tax that would depend on the location of the source and the people affected. Such differentiated tax rates are not easy for a central authority either to determine or, politically, to impose.

Moreover, as we noted earlier, centrally determined, uniform ambient standards for environmental quality are not an efficient policy response in such cases. The problem here is that a given jurisdiction is, in a sense, at the mercy of polluters elsewhere. The most efficient way of attaining the standard (whatever it may be) is likely to involve pollution controls in other jurisdictions over which the state or local authority has no control. An alternative approach is for the central authority to set emissions limitations on polluting activities with spillover effects. But even here, uniform regulations are unlikely to be very satisfactory. A fully efficient system of pollution control must take into account the particular patterns and magnitudes of the flows of pollutants across multiple borders. In fact, Revesz (1996) shows that in the arena of air quality management, federal measures in the United States have not been very effective in addressing the issue of interstate externalities.⁸

⁷Schwab and Oates (1996) show that in a simple two-period model with a housing market in which people move from one jurisdiction to the other at the end of the first period, there takes place the capitalization of environmental and fiscal differentials into housing (land) values, which induces efficient intertemporal decisions regarding levels of environmental quality.

⁸For a careful treatment of this issue in the context of a study of ground-level ozone pollution in the United States and in Europe, see Braden and Proost (1996).

In principle at least, regional cooperation offers the potential for an efficient, Coasian sort of resolution of jurisdictional spillover effects. The basic idea here is that so long as the polluting activities that are the source of the spillovers are not at their efficient levels, there exist potential gains from trade from an interjurisdictional program to regulate these activities. The costs, in such cases, of pollution abatement are less than the benefits accruing to residents of both the home and the neighboring jurisdictions. The difficult problem in practice is designing the cooperative decisionmaking institutions that can realize these gains from trade.

It is useful, I think, to approach this issue in terms of a typology of cases. There is at least one fundamental distinction to be drawn between forms of jurisdictional spillover effects. In the first class of cases, polluting flows are unidirectional. Thus, the polluting activities in one country or state generate environmental damages in a neighboring jurisdiction, but not vice-versa. In the second class of cases, there exists a reciprocal relationship: polluting activities in both jurisdictions spill across the common border.

The first class of unilateral spillover effects, while simpler in one sense, is probably the more difficult to deal with in a regional policy setting. This is because only one party stands to gain directly from the reduced flows of polluting waste emissions; the other jurisdiction will need to undertake the costly activity of cutting back on its polluting activities. In the absence of any form of compensation, there is little in the way of incentives for the source jurisdiction to adopt measures to reduce the flow of pollutants across its borders. Some sort of compensatory mechanism is required if there are to be mutual gains from regional cooperation.⁹

In the second class of interjurisdictional spillovers, there can exist mutual gains from trade without compensation. Here one state can agree to reduce its polluting activities and hence the damage it causes to a neighboring state in return for a similar program in the adjoining state. For this class of cases, there exists a straightforward way for each party to compensate the other in terms of reduced transboundary pollution.

There are, incidentally, lots of actual cases of both classes of interjurisdictional pollution. One common case in the first class is that of a river that flows from one jurisdiction into another; the use of the river in the upstream jurisdiction imposes costs on the downstream users. Similarly, prevailing air currents often convey air pollutants from one set of jurisdictions to those downwind. There are also numerous cases of the second class of reciprocal interjurisdictional

⁹See Baumol and Oates (1988, 278–83) for a discussion of this issue.

pollution flows. Such instances can involve bodies of water, such as bays or lakes, where different jurisdictions occupy segments of the shoreline.

Regional cooperation presents an appealing approach in principle to addressing some forms of interjurisdictional pollution. But such cooperation is not always easy to come by. I shall return to this shortly. But the basic point here is that cases of spillover effects across jurisdictions present us with a fairly complex set of policy alternatives in practice. The first-best measures of economic theory may simply not be feasible. The available alternatives then include not only centrally determined ambient or emissions standards, but also regional programs that involve cooperative management efforts. The second-best alternative may well vary from case to case, although we should be able to say something about the circumstances that tend to favor one approach over the other (List and Mason, forthcoming).

4. What Can We Learn from the Evidence?

Until recently, we have not had much in the way of evidence to bring to bear on the crucial issues in environmental federalism, but in the past few years, some important studies (primarily for the United States) have emerged. I find it helpful to organize the discussion of this work around three separate issues: the existence of a race to the bottom, the potential of cooperative regional measures for environmental management, and the estimation of the potential welfare gains from the decentralized setting of environmental standards.

Is There a Race to the Bottom?

Suppose that there is a race to the bottom. What should we expect to observe over time? If state and local officials have systematically sacrificed environmental quality in their jurisdictions on behalf of economic growth, we should expect to find a record of continuing environmental degradation until some point at which there is central intervention for environmental management. From such point forward, centrally set standards should become the norm. States and localities would presumably not seek to introduce standards more stringent than those set by the central agency because this would put their jurisdictions at a competitive disadvantage in the marketplace.

Is this what we find? Let us begin with an examination of the U.S. experience with air quality management. This should be instructive, inasmuch as most major programs prior to the 1960s were at the state and local levels. Federal involvement began in the 1960s and culminated in the Clean Air Act Amendments of 1970, under which the federal government, under the

auspices of EPA, introduced a set of uniform national ambient air quality standards for a set of “criteria” air pollutants.

The historical record of both emissions of air pollutants and ambient air quality is a rather mixed and complicated one. For some pollutants (e.g., carbon monoxide and nitrogen dioxide), data indicate that there was continuing growth in aggregate national emissions through the decades before 1970, with significant reductions since then (Council on Environmental Quality 1995, chapter 10). However, for other air pollutants, there is clear evidence that things had been improving for a substantial period prior to an active federal role. Estimates of national emissions for particulate matter, for example, reveal a continuing decline since the late 1940s. And this translates into improved ambient air quality. Goklany (1999) provides a comprehensive review of trends in both emissions and ambient air quality insofar as the data permit for before and after 1970. In one set of data based on about 80 urban and 20 rural areas beginning in 1957–58, Goklany (1999) finds a substantial decline in the national average concentration between 1958 and 1970. All this reflects efforts following World War II and extending through the 1960s in many urban areas to address their “smoke” problems. These efforts resulted in dramatic improvements in air quality in such major cities as New York, Pittsburgh, Chicago, and St. Louis. By 1956, there were some 82 local air pollution control programs in place. There is likewise evidence of reduced emissions and concentrations of sulfur dioxide prior to the Clean Air Act Amendments of 1970. On another front, in 1967 California introduced vehicle emissions standards that provided the basis for later federal standards. This is not to contest the real improvements in many dimensions of air quality since 1970, but simply to indicate that there were preexisting effective programs in many areas for the control of at least certain forms of air pollution.

The record, in short, does not seem to support the view that prior to the Clean Air Act Amendments of 1970, state and local agencies were inactive in the realm of air pollution control. On the contrary, as public awareness and concern over air pollution mounted, there was, in fact, a real and substantial response at the state and local levels encompassing a wide range of programs for the improvement of air quality.

In Goklany’s view, the historical record on air quality management is clearly inconsistent with the idea of a race to the bottom. The conventional wisdom that attributes the marked improvements in air quality to federal intervention beginning with the Clean Air Act Amendments of 1970 is simply wrong. As Goklany documents, there were in fact “broad improvements in air quality before federalization. The race, if any, seems to be in the opposite

direction, particularly for those pollutants associated with...the greatest public health risks” (1999, 150).

But there is a second part to my proposed test. Following the mandates of the Clean Air Act Amendments of 1970, EPA introduced ambient air quality standards consisting of maximum allowable concentrations of the criteria air pollutants applicable to every area in the country. If there were a race to the bottom, we might expect that such standards would not be tightened by the states. And with a couple of minor exceptions, this is what we find. States and local environmental authorities have not adopted standards for these pollutants that are more stringent than the federal standards. However, although such behavior is consistent with the existence of a race to the bottom, I think that for the case of air quality management, there is another explanation that is more compelling.

The standards set under the Clean Air Act Amendments of 1970 are *extraordinarily* stringent. Under the legislation, EPA was directed to set uniform standards for air quality “to protect the human health” in such a way as “to provide an adequate margin of safety...from any known or anticipated adverse effects associated with such air pollutant(s) in the ambient air.” Moreover, these standards were to be set without regard to their cost of attainment. This has resulted in a very restrictive set of standards for air quality that many areas have been unable to attain after more than 30 years of continuing efforts.

This is admittedly a complicated issue. Existing benefit-cost studies suggest that the total benefits from air pollution control have substantially exceeded the total costs in the United States. But this, of course, does not really address the relevant question. It is still possible, and I think likely in view of the evidence, that for several of the criteria air pollutants (such as ground-level ozone), the standards have been pushed beyond the point where marginal benefits equal marginal cost. If this is so, then the federal standards (from an economic perspective) are excessive, and we would not expect to find state and local governments tightening these standards yet further. For this reason, I do not take the U.S. experience with air quality standards to provide much support for the race-to-the-bottom view.

We do better, I think, to look to other areas of environmental regulation for more compelling evidence. Of the major environmental statutes, there are two that explicitly require that benefits and costs be weighed against each another in the setting of federal standards: the

Toxic Substances Control Act and the Federal Insecticide, Fungicide, and Rodenticide Act.¹⁰ And it is interesting that in these areas, we find lots of cases where the states have gone beyond the federal standards and in some instances adopted much tougher regulations. Some states, for example, regulate pesticide use more stringently than required under the federal rules (see Grossman 1996). Even under hazardous waste regulation, which is not subject to a benefit-cost test, many states have introduced much tighter measures to regulate the disposal of hazardous wastes than required under the federal Resource Conservation and Recovery Act (see, e.g., Lennett and Greer 1985). All this admittedly requires closer scrutiny to determine the extent to which tougher regulations impose higher costs on local business enterprise. But on the face of it, the cases where state and local authorities have introduced environmental measures that are significantly more restrictive than the minimum federal requirements argue against a race to the bottom.

Some recent researchers have taken an altogether different tack and studied the efforts in the United States in the 1980s actually to decentralize a broad range of environmental decisionmaking. Under the Reagan administration, several actions were taken that moved the responsibility for some environmental management back to the states. Indeed, one of Reagan's principles was to shift environmental responsibilities to the states "whenever feasible." Federal appropriations to federal environmental agencies such as EPA were cut, and there were also large reductions in federal aid to the states for environmental programs. This provides an opportunity, over an admittedly short span, to see how state and local governments responded to the task of taking greater control over their environmental programs. In particular, can we see any evidence of an intensified race to the bottom? Three recent studies have looked at the record. List and Gerking (2000), using state-level data, examine levels of both environmental quality and abatement expenditures. Estimating a fixed-effects model with state-specific and time-specific effects, they employ as a test for the race to the bottom the signs of the time-fixed effects during the years of the Reagan presidency. They find that the majority of the time effects are either insignificant or consistent with improved environmental quality and conclude that "...in this instance, the race to bottom did not appear to materialize" (2000, 454).

In a second assessment of the Reagan experience, Millimet (2000) has undertaken a careful study of airborne emissions of nitrogen oxide and sulfur dioxide and of industry

¹⁰These standards are typically product rather than ambient standards. They govern such things as the ingredients that pesticides may or may not contain, or where and when pesticides can be used.

expenditures on pollution abatement. His technique was to estimate a model for a long period prior to the Reagan and Bush years and then to compare predictions of the model with actual outcomes during those administrations. This exercise finds support for a race to the *top*—at least for abatement spending and nitrogen oxide emissions—since emissions and pollution control expenditures were significantly greater than those predicted by the model.

In a third study that covers a longer time, 1977 through 1994—a period that encompasses the Reagan years—Fredriksson and Millimet (forthcoming) have looked for strategic interaction in environmental management by the U.S. states. And they find evidence of such interdependencies. In a series of regression equations that explain levels of abatement expenditure among the states, they find that spending for pollution control in a given state depends significantly on spending in neighboring states. The form of this interdependency is especially interesting in that it exhibits a basic asymmetry. States appear to be pulled to higher levels of abatement spending by more stringent measures in neighboring states, but relatively lax regulations nearby appear to have no effect on such expenditures. Thus, this study likewise finds no evidence in support of a race to the bottom.

The historical evidence thus does not appear to provide compelling support for the race-to-the-bottom view of environmental federalism. But there are some other kinds of evidence that are of interest here. In particular, there exists a body of empirical work that looks directly at the response of industry location decisions to environmental regulations. The basic idea here is that areas with more stringent environmental regulations should find themselves at a competitive disadvantage that should manifest itself in relatively few new firms or plants in pollution-intensive industries. Some early empirical studies of the issue, in both a domestic and an international context, found little support for this idea. In a study of motor vehicle assembly plants in the United States, for example, McConnell and Schwab (1990) found that regional differences in environmental regulations exerted no apparent influence on the location choices of industry branch plants (see also Crandall 1993 and Bartik 1988). Similarly, in the international context, Tobey (1990) found that the relative stringency of environmental regulations in different countries had no discernible impact on patterns and levels of exports. Thus, this first wave or generation of research led to the conclusion that environmental regulations were themselves such a minor element in the location decisions of polluting firms that they had little impact. In a well-known survey of this work, Jaffe et al. (1995, 157) concluded that “Overall, there is relatively

little evidence to support the hypothesis that environmental regulations have had a large adverse effect on competitiveness, however that elusive term is defined.”¹¹

There is, however, a second generation of research on the issue that, making use of richer and more recent datasets and a wide range of econometric techniques, has turned up measurable effects, in some cases sizable ones, of stringent environmental regulations on location decisions in pollution-intensive industries. Henderson (1996), using a panel dataset and fixed-effects analysis in a careful study of ground-level ozone regulation, found significant differences in industrial location patterns between attainment and nonattainment areas. Henderson found that polluting firms were more likely to stay in attainment areas or, if they relocated, move to attainment areas where they would presumably be subject to less scrutiny and more lenient control measures than in nonattainment areas. Likewise, Becker and Henderson (2000) found that differentials in regulation affected levels of firm births in polluting industries; new plants in these industries exhibited birthrates in attainment areas that were estimated to be 26% to 45% higher than in nonattainment areas.

Other recent studies have also found significant effects of environmental measures on location decisions. List et al. (2001), using a panel dataset from New York State, find evidence suggesting that air quality regulations influence the choice of destination of relocating firms. List and Co (2000) studied the location decisions of foreign multinational corporations in the United States and found that their choices for new plants were sensitive to the stringency of state environmental regulations. Examining the implications of these findings for economic growth, List and Kuncce (2000) explored the impact of environmental regulations on the growth in manufacturing employment; they found that job growth in polluting industries was adversely affected by more stringent environmental measures. In a review and reassessment of this whole body of work, Jeppesen et al. (forthcoming) pull together estimates from a number of studies in a meta analysis that both documents the significance of these effects and suggests the importance of various methodological issues in estimating their magnitude.

We must, however, exercise some care in drawing out the implications of this research. First, a basic finding that polluting firms are responsive in their location decisions to area differentials in the stringency of environmental regulations does not in itself prove that states or

¹¹There is, incidentally, some evidence suggesting that fiscal variables (such as taxes and certain kinds of public spending) have a modest effect on economic development (see Bartik 1991).

localities actually use environmental measures as a competitive instrument. In fact, irrespective of the actual facts on the location decisions in polluting industries, whether officials use environmental regulations for competitive purposes depends largely on perceptions. If policymakers *think* that these regulations matter, then they may well craft environmental legislation in the light of their objectives for economic development. Perceptions matter here. As we have noted, the first generation of research on this issue found little evidence of the responsiveness of location decisions to the stringency of environmental regulations. But in their survey of this work, Jaffe et al. (1995, 148) pointed out that “There appears to be widespread belief that environmental regulations have a significant effect on the siting of new plants in the United States.” Likewise, Engel (1997) found evidence in support of such perceptions. In a survey that she administered to state environmental agency officials, she found that some 88% stated that “concern over industry relocation and siting affects environmental decisionmaking in their state” (1997, 341).¹² But even this must be interpreted with care. For as the theory suggests (see, e.g., the appendix), interjurisdictional competition can lead to efficient outcomes. The fact that such competition exists does not necessarily imply that environmental standards will be too lax.

Finally, there is an interesting and recent paper that finds evidence of free-riding behavior on the part of the states. In a study of federal and state spending under the Endangered Species Act, List et al. (forthcoming) examine a panel dataset on expenditure patterns on endangered species. Their results suggest that states tend to spend less (relative to the federal government) on those species that demand a large habitat area and those whose preservation conflicts directly with economic development. But this is not contrary to expectations. The benefits from the conservation of species are largely nonuse benefits that accrue to people everywhere. In terms of our earlier framework, this is a national (or global) public good—one for which centralized standard setting is needed in order to avoid suboptimal measures.

¹²Engel finds from her survey that “states strive to mimic the standards of other states” (1997, 344). This sort of strategic reaction to policies in neighboring states has also been observed in fiscal matters (see, e.g., the seminal paper by Case et al. 1993). But it need not indicate the presence of a race to the bottom. As noted above, Fredriksson and Millimet (forthcoming) find in their study that such strategic interaction has appeared to work in the opposite direction; they find that it has either pushed or pulled states up to more stringent measures to enhance environmental quality.

Regional Cooperation as an Alternative to Centralization

As we noted earlier, for the case of environmental spillover effects across jurisdictional boundaries, centralization in the form of uniform national standards is, in general, not an efficient solution. Some kind of Coasian cooperative action may offer the opportunity for achieving a more efficient outcome. The difficult problem in practice is the design of cooperative decisionmaking institutions that can realize the gains from trade available from an efficient resolution of the externalities.

The record on the regional approach is a mixed one. Cooperation itself can present major challenges. The literature on such regional compacts is a very large one that cuts across the boundaries of several disciplines—and I cannot hope to encompass it all here. There are episodes of clear failure. One early effort involved the creation of the Delaware River Basin Commission in 1961 as a model regional agency for the management of water quality on the Delaware River and its estuary. The commission, vested with broad decisionmaking powers, included constituencies from the four interested states (Pennsylvania, New York, New Jersey, and Delaware) and the federal government. But the respective parties never seemed able to rise above their parochial interests to reach a regional perspective. Ackerman et al. (1974), in their fascinating and insightful description and assessment of the early years of the experiment, make clear the formidable obstacles to interjurisdictional environmental management. But we may be learning from experience. Despite all the difficulties that it has encountered, the consortium currently managing the Chesapeake Bay presents a more successful story. Subsequent to a voluntary agreement in 1987 among the relevant jurisdictions (Maryland, Virginia, Pennsylvania, and the District of Columbia) and the federal government to reduce pollution flowing into the bay, there are a number of visible signs of improvement in water quality.¹³

Another interesting and important regional experiment in environmental management concerns the control of air pollution. Scientific work in recent years has revealed that ground-level ozone pollution, once thought to be basically a localized problem, involves important elements of long-range transport. In the light of new evidence of the transport of ozone and its precursors, NO_x and VOC emissions, the U.S. Congress in 1990 created an ozone transport region and a commission to address the nonattainment issue for ozone pollution in the Northeast

¹³There is a need for a systematic study of the experience in regional management of the Chesapeake Bay. I know of none.

states.¹⁴ The commission enacted two regional initiatives, one for the adoption of the California low-emissions vehicle program and the other committing the member states to pursue new emissions controls for power plants and other large boilers within their jurisdictions. A serious problem that became apparent is that the ozone transport region is not sufficiently large to encompass the full range of the transport problem. Analysis has indicated, for example, that the most cost-effective NO_x controls would involve reduced emissions in states outside the region, where such emissions reductions are more than an order of magnitude less expensive. This led to the formation of an expanded regional organization, the Ozone Transport Assessment Group, to account for the full geographical scope of transport. An important facet of this program is the explicit recognition of the particular spatial configuration of the ozone transport problem and the incorporation of these spatial features into the program. The member states reached an important agreement on a system for the control of stationary source emissions. Under a NO_x “budget” and a cap-and-trade system, there is an aggregate allowance to each state for its total level of emissions, with the individual states being empowered to allocate their allowances as they see fit. As Farrell et al. (1999) show, this system promises substantial savings over command-and-control options. The trading system seems to be working well: Chartier (1999–2000) reports that the preliminary results for 1999 indicate that sources have achieved reductions in emissions well beyond required levels. Moreover, trading has been widespread (Farrell 2000). It is especially noteworthy that much of the impetus for this program has come from the concerned states themselves, not from federal intervention. The program is still in the process of evolution, but it certainly appears promising. Finding efficient regional and interregional control strategies is complicated, but the potential returns seem quite large.

It is difficult to generalize from these experiences with regional environmental management. Both the circumstances and the institutions differ in important ways. But there is, I think, much to be learned here. A systematic study of such regional efforts that makes use of a sensible categorization into typologies of environmental interaction (e.g., unilateral versus reciprocal pollution flows) and collective decisionmaking institutions might well reveal what sorts of structures and policy measures can work effectively for the regional management of environmental quality. There is an important research agenda here.

¹⁴ Tawil and Dinan (see Congressional Budget Office 1997) provide an excellent description and assessment of the ongoing ozone transport region experience that I draw on here. See also the insightful comparative study by Braden and Proost (1996) of the U.S. and European efforts to regulate ground-level ozone.

Estimates of the Gains from Decentralized Standards

Another empirical approach to environmental federalism is to compare in welfare terms the outcome under uniform national standards for a particular pollutant with that of a decentralized system that allows each jurisdiction to select its own optimal standard. There is only one such study that I know of. It is noteworthy not only for this reason, but also by reason of its striking findings.

The study by Dinan et al. (1999) considers the case in the United States of setting uniform national standards for drinking water. This is an especially relevant case, since it approximates our Benchmark Case 2 of a purely local public good. With minor qualifications, standards for safe drinking water are of concern almost exclusively to the local population; they address contaminants that can be the cause of cancers or other chronic health effects when individuals are subject to long-term exposure. Both the benefits and also the costs of drinking water standards accrue almost wholly to residents.

In 1974 the U.S. Congress passed the Safe Drinking Water Act, which mandated the first set of federally enforceable standards for drinking water (later amended and strengthened in 1986). Under these measures, EPA was directed to set maximum contaminant standards covering some 83 contaminants at a level at which “no known or anticipated adverse effects on the health of persons occur and which allows for an adequate margin of safety.” Later amendments allow for some cost considerations in the determination of the standards, but these appear not to affect the standards because they apply to smaller systems that operate at a much higher per-capita cost.

As the authors discuss, the removal of contaminants from drinking water involves treatment procedures with very large economies of scale. In fact, for the particular contaminants they study (gross alpha emitters), which exhibit approximately linear benefits per household from reduced concentrations, the declining marginal costs imply corner solutions: welfare is typically maximized in a particular community by either zero treatment or complete removal of the contaminant. Their estimates indicate that for smaller systems, the costs of treatment far outweigh the benefits (even using a very generous assumption of \$10 million for the value of avoiding a case of cancer). Welfare losses from the uniform standard vary widely across the size categories in their study; households served by the smallest systems incur estimated losses of \$650 or more per annum, depending upon the initial level of contamination. In fact, only the very largest category of systems exhibits positive net benefits from the standard. *If* we assume that local systems adopt the level of treatment that maximizes such net benefits, the decentralized outcome would clearly be far superior to the universal attainment of the specified standard. This

is a case where the costs of treatment per capita vary so dramatically across jurisdictions that uniform standards come at a very high welfare cost compared with the efficient pattern of local treatment.

5. Some Conclusions and Reflections

Environmental federalism is a complicated issue. Both theory and practice suggest the existence of real tensions and a certain ambivalence about the roles of the different levels of government in environmental management. In concluding this lengthy treatment, let me offer a few thoughts.

Turning first to the role of the central government, we find a major responsibility in supporting research and providing information on environmental matters. Basic knowledge concerning the nature and extent of environmental damages from polluting activities and methods of pollution control are pure public goods on a national (and international) scale. The discovery of a more effective technique for reducing polluting waste emissions, for example, can provide benefits to all jurisdictions. Following the standard arguments, we would expect a purely decentralized system to provide too little in the way of research and development activities because individual state, provincial, or local governments would typically ignore the benefits that such activities provide to residents in other places. The basic research function and, in addition, the dissemination of information on environmental damages and pollution control techniques thus have a public-good character that points to a fundamental role for the central government.

It is important in this regard, however, to recognize that decentralization can provide a valuable dimension in policy innovation by offering the opportunity for experimentation with differing approaches to environmental management (Oates 1999). Under so-called laboratory federalism, there are potential gains from learning by doing so that we can find out how certain kinds of policy measures work in practice without imposing untried systems on the entire nation. In addition, a variety of approaches to regulatory management across jurisdictions can sometimes turn up previously unrecognized methods or instruments. There is, in fact, a major and interesting case of this in the arena of U.S. environmental policy: trading systems for emissions allowances. The introduction in the 1970s and 1980s of a variety of emissions trading systems at the state level demonstrated the feasibility of such systems and some of their very appealing properties—as well as certain pitfalls. Without this experience, I doubt that the United States would have introduced the national system of tradable sulfur allowances under the 1990 Clean Air Act Amendments.

A second role for central government can arise in cases where standardization in pollution control activities across jurisdictions brings large cost-savings. The most obvious case here involves the determination of emissions standards for motor vehicles. It would obviously be very costly for auto manufacturers to produce 50 variants of cars to satisfy the particular emissions standards of each state. There is clearly a case here for central standard setting. At the same time, this may not mean a single standard only. It may prove worthwhile to have, say, two sets of standards, which would allow jurisdictions some limited choice depending on their particular circumstances (as when California set vehicle emissions standards that are more stringent than those required elsewhere in the United States).

When, however, we turn to the general issue of the setting of standards for environmental quality, things become murkier. The benchmark cases that I set forth in the first section of the paper provide some guidance on this. There is the suggestion that for environmental matters that are of strictly local interest (i.e., Benchmark Case 2), a decentralized system of setting ambient standards seems appropriate. The one-size-fits-all approach can result in large welfare losses compared with a system in which individual jurisdictions introduce standards that are the best suited to their circumstances. The Dinan et al. study (1999), as discussed earlier, indicates the potentially significant magnitude of these losses from uniformity.

There are, as I see it, three major objections to the decentralized prescription.¹⁵ The first is the race-to-the-bottom argument. As we saw, this argument is difficult to resolve at a purely theoretical level: different (and plausible) models can produce different results. An empirical literature is only beginning to emerge on this issue, but my reading of the findings is that they really do not provide much overall support for the existence of a race to the bottom. In fact, one can reasonably argue that they point more in the opposite direction—to a race to the top.¹⁶

¹⁵For a forceful statement of the case for the centralization of environmental management based on U.S. experience, see Steinzor (2000).

¹⁶Even if there is some tendency toward laxity arising from economic competition, the important issue is its degree and extent. How large are the welfare losses from the race to the bottom? Although we have no direct evidence on this for the setting of environmental standards, Parry (2001) has recently estimated the welfare losses from tax competition with a computable general equilibrium model. In his model, regional governments have a single tax instrument—a tax on mobile capital—which leads to distorted outcomes resulting from the fiscal interdependencies among jurisdictions. For the case of welfare-maximizing governments, Parry finds that these losses are, on the whole, quite modest—typically less than 3% of revenues. We cannot, of course, directly translate these findings to a setting of regulatory competition, but they do at least suggest that the distortions from interjurisdictional competition may not be very large.

The second objection is the need for expertise. Environmental management is a very complicated matter that involves sophisticated environmental science as well as skilled policy design and enforcement. A large central agency, so the argument goes, can pull together the critical body of experts needed to carry out this work. State and local governments simply do not have the wherewithal to develop and administer effective systems of environmental regulation. Here again, I don't find the argument fully compelling. As discussed above, it makes good sense for a central agency to provide information and guidance on these matters. From this perspective, state and local governments do not have to go it alone. Moreover, much has been written in recent years concerning the impressive improvement in the management capacities of state and local governments. Rivlin (1992, chapter 6), for example, describes the marked strengthening in recent decades of state and local governments in a whole range of fiscal and regulatory capabilities. There is now considerable expertise at decentralized levels of government, especially when seen against the background of centrally provided support. As an aside, the expertise argument surely carries little weight in the case for harmonization in the European context, where member states have plenty of experts.

The third argument against decentralization is more anecdotal in character. It has to do with political clout (and may, perhaps, be regarded as a variant of the race-to-the-bottom proposition). Proponents often set up the argument by conjuring a company town somewhere that is dominated by the company's representatives. Industrial interests inevitably prevail, so needed pollution control measures never have a chance. There may be actual instances of this, although it is hard to know how prevalent the situation is in fact. But once again, although the argument may have some force under special circumstances at the level of relatively small jurisdictions, it is less likely to characterize outcomes at state or provincial levels—and it has little relevance to arguments for harmonization across the European Union.

My own sense is that where environmental quality is basically a local public good, the case for the setting of environmental standards at an appropriately decentralized level of government is quite compelling. At the same time, one can envision an essential informational and guidance role for the central authority. With the substantial scientific and policy expertise at its disposal, a central agency can effectively provide a menu of options for standards and a choice of policy instruments. Such guidance would become an important resource for state and local officials and their constituencies in the actual design of decentralized environmental programs.

When we turn to Benchmark Case 3, however, things become yet more difficult. Here we have the case where local polluting activities degrade not only the immediate environment but

spill over to some degree into neighboring jurisdictions. A purely locally determined outcome in such circumstances cannot be expected to be efficient. But neither is an outcome in which the central government establishes uniform standards across all jurisdictions. A third alternative is some kind of cooperative or regional program that involves joint decisions on the part of the relevant jurisdictions.

None of the three alternatives may be *generally* preferable to the other two. Local decisionmaking, especially if the spillover effects are pronounced, is likely to result in excessive pollution. Centralized measures will typically exhibit a tendency toward national uniformity that will impose welfare losses relative to the efficient pattern of outcomes requiring local differentials in standards that reflect the varying benefits and costs across jurisdictions. Regional cooperation offers, in principle, opportunities to internalize interjurisdictional spillover effects with the design of policy measures that address particular conditions. But in practice such things as regional compacts present a formidable challenge; it is hard to be sanguine about a general presumption that they will always produce superior outcomes.

I thus find it difficult to reach a general conclusion for this pervasive third class of cases. A better approach might be to determine the particular circumstances that favor one of the three alternatives over the others. Such considerations may involve the extent of the interjurisdictional spillover effects, the geographical configuration of the relevant jurisdictions and pollutant flows, the ease of monitoring emissions, and the structure of environmental regulation within these jurisdictions. Prescribing one alternative to the exclusion of the others is, in my view, unwise. My sense, for example, is that we may not have been well served in the United States by a system of air quality management that imposes a uniform set of national ambient standards for all pollutants. Circumstances are simply too different to warrant such uniformity, as the persistence of so many nonattainment areas suggests. The efficient levels of concentration of air pollutants in Los Angeles are surely very different from those in Buffalo—and for certain pollutants it will make sense to recognize those differences. Likewise for Paris and Venice.

Appendix

The model presented here is a consolidation of three earlier models of interjurisdictional competition (Oates and Schwab 1988, 1991, 1996) and is quite rich in terms of local public activity. In the model, local governments engage in an array of activities: they provide a local public good for their residents; they provide a local public input for firms that increases the marginal productivity of private capital in the jurisdiction; they set a standard for local

environmental quality that translates into a limited allowance of polluting emissions for local firms; and they tax both residents and firms. We find in such a model that interjurisdictional competition leads to Pareto-optimal outcomes. Local governments effectively employ benefit taxes that lead to efficient private and public decisions.

Since the various elements of the model have been presented and discussed in detail elsewhere (Oates and Schwab 1988, 1991, 1996), I simply summarize the expanded model in Table 1 and discuss it briefly here. Its structure is embodied in the six equations in the first section of the table. In equation (1), we have the production function for the jurisdiction, in which output is a function of the jurisdiction's given stock of labor, L ; its endogenous stock of capital is K , the level of a publicly provided input is X , and the level of waste emissions is E . The publicly provided input (X) could consist of things like local roads, police protection, and refuse collection.¹⁷ Waste emissions (E) are a by-product of productive activity and result in pollution that causes disutility to residents (but such pollution is assumed, for now, to be wholly localized and not to spill over into other jurisdictions).¹⁸ Assuming constant returns to scale, we can write the production function as $Lf(k,x,e)$, where k is the capital-labor ratio, x is the public input-labor ratio, and e is the emissions-labor ratio.

Equation (2) indicates that in a competitive labor market, the real wage equals the marginal product of labor. Workers, incidentally, are assumed to live and work in the same jurisdiction. In equation (3), r is the rate of return to capital in the national capital market; thus, in equilibrium, the capital stock in the jurisdiction will adjust until its net return there is r . As we see in (3), the net return to the owners of capital is the return after adjusting for the enhancement of the productivity of capital from the locally provided public input (x) and from waste emissions (e), and after deducting the local tax on capital (t).

In equation (4), we find that the utility of each (identical) resident depends upon the level of private consumption (c), on the output of a publicly provided consumption good (g), and on the collectively consumed level of local pollution (e). Here e is a local public "bad."

¹⁷I assume that the publicly provided input is not a Samuelsonian public good but is subject to congestion like a private good. The input is taken to be allocated among producers according to the size of their capital stock, so the public input-capital ratio is the same for all firms. The idea here is that larger private facilities receive proportionally more of such things as sewer and refuse services, police services, training programs, and so forth.

¹⁸Waste emissions (like the public input) are taken to be allocated among firms in proportion to their capital stock. This assumption is not essential to the results, but it facilitates the analysis.

Finally, equations (5) and (6) describe the two relevant budget constraints in the system (expressed in per-capita terms). In equation (5), public revenues consist of head tax receipts from residents (h) plus taxes on capital (kt), which together must equal public expenditures on the locally provided consumption good (g) and on the public input to local firms (x). I assume that the local government can purchase units of both g and x at predetermined prices of p^g and p^x . The individual's budget constraint in equation (6) indicates that income consisting of an exogenous component (y) plus wages (w) equals the sum of spending on private consumption (c), where the price of c is taken to be unity, and the individual's local tax payment (h). For simplicity, it is assumed that the revenues from taxes on capital are distributed equally among the jurisdiction's residents in the form of a credit against the resident's tax liability; thus, the head tax (h) is understood to be net of this credit.

The central interest in this model is on the various policy instruments available to the local government for competing in the national market for capital. The incentives in the model for encouraging an inflow of capital are straightforward. A larger capital stock increases the capital-labor ratio, thereby enhancing the productivity of labor and raising the level of real wages. In addition, the local capital stock constitutes a tax base from which local revenues can be raised.

Local government has, in the model, an array of policy instruments with which to influence local economic activity. There are five policy parameters to be determined: the level of the publicly provided input to private firms (x), the allowable level of polluting waste emissions (e), the output of the publicly provided consumption good (g), the tax rate on capital (t), and the head tax (h) on residents.

Let us assume that the community operates under simple majority rule. The values of the policy variables, then, are those that emerge from a median-voter model. Note that since all residents in a given jurisdiction have identical utility functions and income, this amounts simply to maximizing the utility of a representative resident—namely, equation (4)—subject to the various constraints contained in the other equations.

The model captures the spirit of interjurisdictional competition in terms of the various trade-offs that it presents to residents and their public officials. As noted, it is in the jurisdiction's interest to encourage the inflow of capital both to raise wages and to augment the local tax base. Revenues can be realized from taxing capital at rate t . Of course, the larger t is, the more capital is deflected away from the jurisdiction, resulting in a reduced level of wages. It is possible in the model for t to be negative, in which case the community would subsidize capital in the

expectation of a higher level of wage income. A related trade-off involves the level of publicly provided inputs (x). Increasing x enhances the productivity of capital and encourages an inflow of capital with resulting higher wages and tax revenues. However, these inputs are provided at a cost to the public treasury that must be balanced against the benefits from the associated inflow of capital.

Another set of trade-offs arises in determining the level of local environmental quality. By reducing the level of waste emissions, e , residents can directly raise their utility level. However, this comes at a cost. Tougher environmental regulations reduce the productivity of capital and hence deflect capital to other jurisdictions. Thus, residents must choose a level of environmental quality that balances their demands for a healthy environment against their demand for private consumption.

Section II in Table 1 summarizes the first-order conditions that must be met in setting these policy parameters in order to maximize the welfare of residents. These reflect the outcomes under the median-voter model. We see (not surprisingly) in (1) that the output of the publicly provided consumption good should be extended to the point where the marginal rate of substitution of each resident equals the cost of providing another unit of the good. Equation (2) indicates that the publicly provided input to firms should be such that its marginal product equals its price. In (3), we find that the environmental standard should be set such that the marginal value of environmental quality equals forgone output. Finally, we see in (4) that the local tax per unit of capital has two components: it is equal to the increase in output of a unit of capital attributable first to the public input and second to its waste emissions. Or, in short, the community should employ a benefit tax on business firms that essentially charges them for the value of the services that the jurisdiction provides in the form of public inputs and environmental services.

Next, we find in section III of the table that the conditions for social optimality are satisfied by the median-voter outcome in section II. The first three conditions for optimality for society as a whole correspond directly to the corresponding first-order conditions for welfare maximization on an individual community basis. The fourth condition requires that the marginal product of capital be equated across jurisdictions. This will be satisfied if each community taxes

capital on a benefit basis with t^i set equal to the contribution to the marginal productivity of capital afforded by the local publicly provided input and waste emissions.¹⁹

¹⁹ If there were no public inputs or environmental services to enhance the local productivity of capital, then the first-order conditions imply that the optimal tax on capital in each jurisdiction is zero. Gordon (1986) establishes this result for a small open economy in an international setting.

Table 1. A Model of Interjurisdictional Economic Competition*I. The Model*

- (1) $Q = F(K, L, X, E) = Lf(k, x, e)$ Production function
- (2) $w = f - kf_k - xf_x - ef_e$ Wages
- (3) $f_k + (x/k)f_x + (e/k)f_e - t = r$ Rate of return to capital
- (4) $u = u(c, g, e)$ Utility function
- (5) $h + kt = p^g g + p^x x$ Public budget constraint
- (6) $y + w = c + h$ Private budget constraint

II. Median-Voter Outcome: First-Order Conditions

- (1) $MRS_{g,c} = p^g$
- (2) $f_x = p^x$
- (3) $MRS_{e,c} = f_e$
- (4) $t = (x/k)f_x + (e/k)f_e$

III. First-Order Conditions for Social Optimality

- (1) $MRS_{g,c} = p^g$ for each jurisdiction
- (2) $f_x = p^x$ for each jurisdiction
- (3) $MRS_{e,c} = f_e$ for each jurisdiction
- (4) $f_k = f_k$ for all i, j

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