November 2000
Preliminary Draft

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. For pollution problems that spillover jurisdictional boundaries, it is hard to reach a general presumption concerning the most effective approach to regulation among the three alternatives of centralized management, decentralized control, or regional cooperation--all of which entail second-best outcomes. The preferred alternative is likely to depend on the particular circumstances associated with the specific pollution problem. The central government, in addition to setting standards for "national pollutants," has a fundamental contribution to make in terms of supporting research in environmental science and pollution-control technology and in providing needed information and guidance to state and local government.

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Environmental policy-making 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 decision-making 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 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 EU commitment to the principle of subsidiarity that establishes a basic commitment to decentralized policy-making (where it is within the capacity of member states and their jurisdictional authorities) and

the sense on the part of some that European-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 environmental quality. It is commonplace for environmental measures to take the form of centrally determined standards with the responsibility for implementation lodged with state or provincial governments. Environmental policy is thus often a joint activity in this limited sense. But the fundamental decision is one of just how stringent environmental measures are to be: meaningful decentralization thus entails "local" determination over the stringency of the standards for environmental quality.

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 the setting of environmental standards. The latter part of the paper offers a survey of the empirical work on this matter. Some recent studies provide valuable insights into this issue. In the final section, I offer some reflections on all this for the structure of environmental decision-making.

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[1]More 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, Art. 36). For an excellent collection of papers on environmental decision-making in a federal system that draws both on the U.S. and European experiences, see John Braden, Henk Folmer, and Thomas Ulen (1996).

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 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 local constituencies. In this setting, we consider three different kinds of pollutants.

a) 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 reqional differentials. What I have in mind can be expressed as:

(1) $Q = f(E)$

where Q 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 ith local jurisdiction. Thus, environmental quality in general varies across the different 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

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the ith jurisdiction, depends on the aggregate level of emissions, E. Moreover, emissions in any

given jurisdiction spillover by degrading the environment in other jurisdictions so that 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 tradeable emission 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 both of these matters, environmental degradation is, in the sense I have used it,

a global public good. A unit of CO_2 emissions, or of CFC emissions in the second instance, has

the same effect on global environmental quality irrespective of its location. And, as is

universally recognized, these problems require a global solution.

b) Benchmark Case 2: Local Public Good. The second prototypical case is one for which

environmental quality is a pure 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:

(2) $Q_i = g(e_i)$

so that the level of environmental quality in the ith 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 determination of 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 (the summation taking place over the residents of the jurisdiction under consideration) equals marginal abatement cost. This, on the face of it, calls for a decentralized determination of environmental quality with each jurisdiction setting its own appropriate standard for pollution control. The efficient outcome here will, in general, involve differing levels of environmental quality across the various 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.[2]

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 that suggests the presence of a "race to the bottom" in a setting of decentralized environmental decision-making, even for the case of a pure local public good.

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[2]The case for the decentralized provision of local public goods has been formalized in terms of the so-called "Decentralization Theorem" (Oates 1972, ch, 2). In the treatment of this proposition, we find that the magnitude of the gains from decentralization (as compared to a uniform level of output across all jurisdictions) depends on the price elasticity of demand (Oates 1997). In particular, the more price inelastic the demand, the greater the welfare gains from decentralization. In light of this, it may be useful to explore whatever information we have on the price elasticity of demand for various forms of environmental quality to get some sense of the potential welfare gains from the decentralization of environmental management.

c) <u>Benchmark Case 3: Local Spillover Effects</u>. The third Benchmark Case is the most common in practice. Here the effects of local waste emissions entail both local pollution and some external effects on other (most likely neighboring) jurisdictions. We thus have:

(3) $Q_i = h(e_1, e_2, ..., e_n)$.

Here the level of environmental quality in jurisdiction $\underline{i}$ depends on the particular pattern of emissions in all $\underline{n}$ localities. There are numerous instances of both air and water pollution where polluting activities in one jurisdiction flow across boundaries (sometimes over long distances like 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 decision-making. 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 <u>not</u> 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 economists 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 compelling. The central government must either specify some set of differentiated taxes directly on polluting sources across the nation, or it must 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 re-examine 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 that addresses both local public finance and environmental regulation that claims that even for this case, decentralized decision-making is not appropriate--that it results in distorted outcomes which typically exhibit suboptimal outputs of local public goods or, in our case, excessive levels of local pollution.

The basic claim 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 that result in suboptimal outputs of local public goods (including environmental quality). In one sense, such a claim 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 exceeds its 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.[3] Let me first point

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[3]As 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 fiscal competition, Dietmar Wellisch (2000) has recently provided a superb, systematic and comprehensive treatment of the theoretical literature. John Wilson (1999) has also given us an excellent explication and survey in his recent paper. On the more limited theoretical issue of

out that it is straightforward to construct a standard kind of model of local public decision-making in which competition among governments induces efficient local choices (e.g., Oates and Schwab 1988, Wellisch 2000). In these models, local jurisdictions compete for mobile firms in order to increase local wage income and to 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, "small" governments (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 local 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 Robert 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

decentralized environmental decision-making in a setting of economic competition, see again John Wilson (1996) for a valuable review. I provide a more terse treatment in my recent survey paper on fiscal federalism (Oates 1999). 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, Richard Revesz (1992, 1996), Daniel Esty (1996), Kirsten Engel (1997), and the collection of essays edited by Esty and Damien Geradin (forthcoming).

range of needed tax and regulatory instruments so that they can effectively engage in benefit

taxation by taxing 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.

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 that it cannot engage solely in

benefit taxation. In the simplest case, such models assume that local governments can only tax

capital so that all public services (those for residents as well as local firms) must be financed by a

tax on mobile capital. In this framework, the seminal papers by George Zodrow and Peter

Mieszkowski (1986), John Wilson (1986) and David Wildasin (1989) show that such nonbenefit

taxation of capital by local governments leads not only to a regional misallocation of capital, but

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 local public services entails not

only the resource cost, but also 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 jurisidictions are not small and where they engage in strategic interactions with their

neighbors.

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.[4]

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 <u>magnitude</u> of any distortions that result from interjurisdictional competition. If the deviations from efficient outcomes are small, then the race to the bottom may be a very short one and may not matter

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[4]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 (William Hoyt 1991).

much. 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 the measurement of 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., Timothy Bartik 1991). But this doesn't really address the question. The issue here is that under some circumstances, such competition may be efficiency-enhancing; in other settings, it can lead to distorted outcomes. Thus, the finding that 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 excessively lax local environmental standards. What is the alternative? Standard economic theory would prescribe some sort of matching grant, or subsidy, from the central government to local governments to induce them to adopt somewhat 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, Daniel Farber (1997), a legal scholar, contends that even if decentralized decision-making 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 a very mixed one. So, if there is a race to the bottom, we are

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left with a choice between two inefficient alternatives: suboptimal local decisions on environmental quality or suboptimal uniform national standards. And which of these two alternatives leads to a higher level of social welfare is, in principle, unclear. Empirical studies of these alternative regimes are needed to shed light on this issue.

FInally, let me take up a related concern about decentralized environmental management that arises in an intertemporal context. Some have alleged that centralized control is required because local decision-making 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 quite likely 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 future; they will better preserve the environment for future generations.

This contention, however, is, in one very fundamental way, quite misleading. There is, in fact, a quite 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 local jurisdiction are effectively forced into taking into account the impact of their current decisions on the future state of the local

environment.[5] Central decision-makers do not face such a disciplining force; thus, it is conceivable that certain classes of local decisions may provide better safeguards for 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 challange in practice for environmental management. Policy makers in one jurisdiction will 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 particular location of the source and the "victims." 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

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[5]Schwab and I (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.

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 different borders; a system of uniform emissions standards is unlikely to be very efficient. In fact, Richard Revesz (1996) shows that in the arena of air-quality management, federal measures in the U.S. have not been very effective in addressing the issue of interstate externalities.[6]

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 interjuridictional program to regulate these activities. The costs, in such cases, of pollution abatement are less than the benefits accruing <u>both</u> to residents of the home and neighboring jurisdictions. The difficult problem in practice is the design of a set of cooperative decision-making 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

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[6]For 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 John Braden and Stef Proost (1996).

jurisdictions spillover the common border.

The first class of unilateral spillover effects, while the simpler one 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. One jurisdiction will need to undertake the costly activity of cutting back on its polluting activities, while the other jurisdiction will receive benefits from these controls. 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 outside its borders. Some sort of compensatory mechanism is required here if there are to be mutual gains from regional cooperation.[7]

In the second class of interjurisdictional spillovers, there can exist mutual gains-from-trade wihout compensation. Here one state can agree to reduce its polluting activities and hence the damages its does 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 trans-boundary pollution.

There are, incidentally, lots of actual cases of both of these 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 interjurisdictioanl pollution flows. Such instances can involve bodies of water, such as bays or lakes, where different jurisdictions occupy segments of the shoreline.

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[7]See Baumol and Oates (1988, pp. 278-283) for a discussion of this issue.

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 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.

4. What Can We Learn from the Evidence?

Until quite 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 last few years, some important studies (primarily for the U.S.) 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.

(a) 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 market place.

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 1960's were at the state and local levels. Federal involvement took place in the 1960s, culminating with the Clean Air Act Amendments of 1970 under which the federal government, under the auspices of the Environmental Protection Agency, introduced a set of uniform national ambient air quality standards for a set of key (the so-called "criteria") air pollutants.

The historical record both of 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), existing data indicate that there was continuing growth in aggregate national emissions through the decades prior to 1970 with significant reductions since then (Council on Environmental Quality 1994-95 Report, Ch. 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. National emissions' estimates for particulate matter, for example, reveal a continuing decline since the late 1940s. And this translates into improved ambient air quality. Indur Goklany (1999) provides a comprehensive review of trends in both emissions and ambient air quality insofar as the data will permit for periods prior to and after 1970. In one set of data based on about 80 urban and 20 rural areas beginning in 1957-58, Goklany (pp. 53-5) 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

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efforts resulted in dramatic improvements in air quality in a number of major cities including 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, the State of California introduced vehicle emissions standards in 1967 which 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 widespread and 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 as regards air-quality management is clearly inconsistent with the claims for a race to the bottom. The "conventional wisdom" which 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" (p. 150).

But there is a second part to my proposed test. Following the mandates of the CAA of 1970, the U.S. 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 that the federal standards. However, while 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 CAA of 1970 are extraordinarily stringent. Under the legislation, the EPA was directed to set uniform standards for air quality "to protect the human health" and to do so 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 twenty-five 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 well 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 on this. Of the major environmental statutes, there are two that explicitly require that benefits and costs be weighed against one another in the setting of federal standards: the Toxic Substances Control Act (TSCA) and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). 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, have adopted much tougher regulations. Some states, for example, regulate pesticide use more stringently than required under the federal rules in FIFRA (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 (RCRA) [see, for example, Lennett and Greer 1985]. All this admittedly requires closer scrutiny to determine the extent to which these tougher regulations impose higher costs on local business enterprise. But on the face of it, there are lots of cases where state and local authorities have introduced environmental measures that are significantly more restrictive than the minimum requirements established by federal regulations.

Some recent work has taken an altogether different tack on this. We do have a post-1970 experience in the U.S. with an effort actually to decentralize a broad range of environmental decision-making. Under the Reagan Administration in the 1980s, several actions were taken that moved the responsibility for environmental management on a vareity of fronts 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 the 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? Two recent studies have looked at the record. John List and Shelby Gerking (2000), using state level data, examine both levels of environmental quality and abatement expenditures. Estimating a fixed effects model with both 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."

In a further assessment of the Reagan experience, Daniel Millimet (2000) has undertaken a careful study of airborne emissions of nitrogen oxide and sulfur dioxide and of industry expenditures on pollution abatement. His technique is 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, rather than a race to the bottom--at least for abatement spending and nitrogen oxide emissions--as emissions and pollution control expenditures were signicantly greater than those predicted by the model.

The historical evidence thus does not appear to provide compelling support for the race-to-the-bottom perspective on environmental federalism. But there are some other kinds of evidence that are relevant here. In particular, there exists a body of empirical work that has explored directly the response of industry location decisions to environmental regulations. Both

economists and political scientists have carried out a substantial number of studies of the impact of state environmental regulations on plant location.[8] These studies take several forms. One consists of surveys of manufacturing plant executives who participated in plant location decisions. A second type of study (e.g., Crandall 1993) uses aggregate data to explore the industrial performance of various states relative to a number of variables including various indices of the stringency of environmental programs. And a third class of studies make use of establishment-level microeconomic data (e.g., Bartik 1988; McConnell and Schwab 1990) to explore econometrically the impact of environmental regulations on plant location decisions. The findings in nearly all of these studies suggest that the stringency of environmental standards is at most only a minor determinant of firm location. And these results apply to a variety of different industries. Much more important in location decisions are such factors as access to markets, labor market conditions, and the quality of schools and housing. Thus, this body of empirical work seems, on the whole, to suggest that there is not much scope for a race to the bottom at least in the environmental arena.[9]

However, it does not necessarily follow from such findings that states do not use environmental regulation as a competitive instrument. Perceptions matter here. And as Jaffe et al. (1995) point out, "There appears to be widespread belief that environmental regulations have a significant effect on the siting of new plants in the United States" (p. 148). If policy makers think that these regulations matter, then they may well craft environmental legislation in the light

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[8]For a useful survey of these studies, see Engel (1997).

[9]There 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).

of their objectives for economic development. Kirsten Engel (1997) finds some evidence in support of this phenomenon. In a survey that she administered to state environmental agency officials, she found that some 88 percent stated that "...concern over industry relocation and siting affects environmental decisionmaking in their state" (p. 341).[10] But even this must be intepreted with care. For as the theory suggests, interjurisdictional competition can lead to efficient outcomes. The fact that such competition exists does not necessarily imply that environmental standards will be excessively lax.

(b) 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 setting 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 a set of cooperative decision-making 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, in fact, often presents 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 clear episodes of failure. One such early effort involved the creation of the Delaware River Basin

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[10]Engel also finds from her survey that "states strive to mimic the standards of other states" (p. 344). This sort of "strategic" reaction to policies in neighboring states has also been observed in fiscal matters [See the seminal paper by Case, Rosen, and Hines (1993)]. But it need not indicate the presence of a race to the bottom. In fact, Per Fredriksson and Daniel Millimet (2000) 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.

Commission (DRBC) in 1961 as a new "model regional agency" for the management of water quality on the Delaware River and Estuary. The DRBC, vested with broad decision-making 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. Bruce Ackerman et al. (1974), in their fascinating and insightful description and assessment of the early years of the DRBC experiment, make clear the formidable obstacles to interjurisdictional environmental management. But we may be learning from experience. With all the difficulties that it has encountered, the evidence suggests more in the way of success for the "consortium" currently managing the Chesapeake Bay. 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 in the Bay.[11]

Another intriguing and important regional experiment in environmental management involves 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, NOx and VOC emissions, the U.S. Congress in 1990 created an ozone transport region (OTR) with its commission (OTC) to address the nonattainment issue for ozone pollution in the Northeast

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

states.[12] The OTC has managed to enact two regional intiatives, one for the adoption of the California Low Emissions Vehicle program and the other committing the states to pursue new emissions controls for power plants and other large boilers within their jurisdictions. But this is taking place subject to some opposition and challenges from certain of the states in OTR. One serious problem appears to be that OTR is not sufficiently large to encompass the full range of the transport problem. Some recent analysis has indicated, for example, that the most cost-effective NOx controls would involve reduced emissions in states outside the OTR, where such emissions reductions are more than an order of magnitude less expensive. This has led to the formation of an expanded regional organization, the Ozone Transport Assessment Group (OTAG), to account for the full geographical scope of transport. A second problem (like that of the DRBC) is that the benefit-cost ratios appear to vary quite dramtaically across the participating states, making it difficult to reach a consensus on policy measures. Finding efficient regional and inter-regional 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 decision-making institutions might well reveal what sorts of structures and policy measures can work effectively for the regional management of

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[12]Natalie Tawil and Terry Dinan (see Congressional Budget Office 1997) provide an excellent description and assessment of the ongoing OTR 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.

environmental quality. There is an important research agenda here.

(c) 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 Terry Dinan, Maureen Cropper, and Paul Portney (1999) considers the case in the U.S. of setting uniform national standards for drinking water. This is an especially relevant case, since it approximates our Benchmark Case (2) of a pure 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 local residents.

The U.S. Congress passed in 1974 the Safe Drinking Water Act (SDWA), which mandated the first set of federally enforceable standards for drinking water (later amended and strengthened in 1986). Under these measures, the U.S. 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 as they apply to smaller systems that operate at 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 contaminant they study (gross alpha emitters), which exhibits approximately linear benefits per household from reduced concentrations, the declining marginal costs imply corner solutions: welfare is typically maximized in a particular community either by 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 to 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 on all this.

Turning to the role of the center, it seems clear, first, that the central government has 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 new and 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 has 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, an interesting case of this in the arena of environmental policy in the U.S. The development in the 1970s and 1980s of a variety of Emissions Trading Systems at the state level demonstrated the feasibility of such systems. Without this experience, I doubt that the U.S. would have introduced the national

system of tradeable 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 involves 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 have to produce 50 different 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 that would allow jurisdictions some limited choice depending on their particular circumstances (as is the case in the U.S. where California has set emissions standards that are more stringent than those required elsewhere).

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 strictly of "local" interest (i.e., Benchmark Case 2), a decentralized system of setting standards seems appropriate. The "one-size-fits-all" approach can result in large welfare losses compared to a system in which individual jurisdictions introduce standards that are the best suited to their own circumstances. The Dinan, Cropper, and Portney study (1999), as discussed earlier, indicates, for a particular contaminant, the potentially significant magnitude of these losses from uniformity.

There are, as I see it, three major objections to this prescription. 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. There is an empirical literature

beginning to emerge on this issue. And 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 rather than to the bottom.

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, there has been much written in recent years concerning the impressive improvement in the management capacities of state and local governments. Alice Rivlin (1992, ch. 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 considerable expertise now 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). The claim is often set forth by visualizing a company town somewhere that is dominated by the

company's representatives. Industrial interests inevitably prevail so that needed pollution-control measures never have a chance. There may be actual instances of this, although it is hard to know how prevalent it is in fact. But once again, while the argument may have some force under special circumstances at the level of relatively small, local jurisdictions, it is less likely to characterize outcomes at state or provincial levels--and again 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 a most valuable informational role for the central authority. With the substantial scientific and policy expertise at its disposal, a central agency could effectively provide a menu of options for the stringency of standards and the choice among 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 spillover to some degree into neighboring jurisdictions. A purely locally determined outcome in such circumstances cannot be expected to be an efficient one. But neither is an outcome where the central government establishes uniform standards across all jurisdictions. And yet 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 decision-

making, especially if the spillover effects are quite 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 hard to reach a general conclusion for this quite pervasive class of cases. A better approach is probably one that tries to understand the particular circumstances that favor one of the three alternatives relative to 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 juridictions. A blanket approach involving one alternative to the exclusion of the others is, in my view, unwise. My sense, for example, is that we have not been well served in the United States by a system of air-quality management that imposes a uniform set of national standards for all pollutants. Circumstances are simply too different to warrant such uniformity, as the persistence of so many non-attainment areas suggests. The efficient levels of concentration of different 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 that my colleague, Robert Schwab, and I have assembled (Oates and Schwab (1988, 1991, and 1996). I thought it might be useful to pull together here such a consolidated model that 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 <u>given</u> stock of labor, L, its endogenous stock of capital, K, the level of a publicly provided input, X, and the level of waste emissions, E. The publicly provided input (X) could consist of things like local roads, police protection, and refuse

collection.[13] Waste emissions (E) are a byproduct of productive activity that 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).[14] 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 jusidiction. 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 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." 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)

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[13]I 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 that 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.

[14]Waste 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.

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 local residents.

Let us assume that the community operates under simple-majority rule. So the values of the policy variables 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 tradeoffs that it presents to local 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 the rate, t. Of course, the larger is t, 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 tradeoff 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 tradeoffs arises in determining the level of local environmental quality. Residents, by reducing the level of waste emissions, e, 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, local residents must choose a level of environmental quality that balances their demands for cleanliness 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 local 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 foregone 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 local business firms that essentially charges them for the value of the services that the jurisdiction provides to them 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.[15]

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[15] 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. Roger Gordon (1986) establishes this result for a small open economy in an international setting.

TABLE 1

A Model of Interjurisdictional Economic Competition

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

Median-Voter Outcome: First-Order Conditions

1) $MRS_{g,c} = p^g$

2) $f_x = p^x$

3) $MRS_{e,c} = f_e$

4) $t = (x/k)f_x + (e/k)f_e$

First-Order Conditions for Social Optimality

1) $MRS_{g,c} = p^g$ for each jurisdiction

2) $f_x = p^x$ for each jurisidction

3) $MRS_{e,c} = f_e$ for each jurisdiction

4) $f_k = f_k$ for all i,j

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