Choosing Environmental Policy Tools

Theoretical Cautions and Practical Considerations

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Washington, D.C.
June 1996—No. ENV-102

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Executive Summary

Interest in the environmental problems of developing countries has led to a growing literature on the choice of policy instruments. The message of that literature tends to be that developing countries should embrace and put in place management systems based on economic incentives (sometimes called market-based incentives) such as marketable permits (to pollute or otherwise stress the environment) or, better yet, charges per unit of the stress. This message is supported primarily by arguments, first, that economic incentives produce least-cost solutions to environmental problems and, second, that they involve a "double dividend" of revenue for hard-pressed governments that are often saddled with poorly designed and administered tax systems.

This report probes the wisdom of this blanket prescription from several points of view. First, it clears up the debate's background about instruments, and the terminology of instrument classification. In particular, the phrase "command and control" is rejected as a label for all instruments other than economic incentives, the argument being that it should apply only to a small subset of those alternatives—the ones that specify both *what* is to be achieved and *how*.

Next, the static efficiency basis for recommending economic incentives is challenged on the basis that attaining static efficiency in the general case in which location matters implies a very heavy information and calculation load, either for the responsible agency (with charges) or the sources themselves (marketable ambient quality permits). A second problem is the other side of the "double dividend" coin—the transfer payments they imply can be very large; indeed, of the same order of magnitude as the resource costs of controlling the activity being charged. Finally, the awkwardness of the lack of a second best result, justifying some form of charges as better than other forms of regulation, is noted.

The requirements for centralized information implied by the static efficiency goal may be linked to government capability more generally. This notion is pursued by a discussion of the evolution of government capability as part of the development process, using a typology of traditional, transitional, and modern. The institutional discussion notes how the commercial/industrial and rural sectors of Latin American economies may be expected to evolve—at least under current fashions in economic prescriptions.

Taken together, the cautionary materials about the economic properties of economic incentive instruments, and government capabilities relative to the demands imposed by those instruments lead to a set of recommendations that:

- are tuned to the level of institutional development of the nation in question;
- look very different, especially for the "traditional" phase of development, from the recommendations of the rest of the instruments literature; and
- look more favorably on economic instruments as the level of institutional capability approaches "modern."

The report closes with a preliminary catalog of what is actually being attempted in Latin America. In the institutionally better developed nations several efforts to use economic instruments are observed. But many other experiments with other instruments seem also to be underway. The less institutionally developed nations seem to be doing less across the board, not just in the application of economic incentives. Possible reasons for this general lack of action are suggested but no definitive answer is available without substantial field investigations.

Introduction

Orientation

Development experts have discovered the environment and "sustainability," and a few environmental economists have discovered the developing countries, with their especially challenging mix of problems. Out of all this excitement of mutual discovery has come a flood of enthusiasm—some more, some less restrained—for economic instruments of environmental policy as prescriptions for developing countries (Anderson, 1990; Eskeland and Jimenez, 1992; Bernstein, 1993; Bruce and Ellis, 1993; Panayatou, 1994; Hansen, 1995; Andrew, 1995; Business Council on Sustainable Development in Latin America, 1995; and United Nations Economic and Social Council, 1995).

This enthusiasm is hardly surprising, given the positive tone of the environmental economics literature on policy instruments. It is even less so when one adds the so-called "double dividend" claimed for charge-like instruments. This double dividend is argued to arise because the tax on a "bad" lowers the total dead weight loss imposed on the economy when it substitutes for a tax on a "good," such as labor effort, as a raiser of government revenue (for critical commentary, see Bohm, 1995).

It would be too strong to call this report an antidote to the enthusiasm for economic incentives for environmental management in developing countries. Better, to think of it as a caution of the following four forms.

First, the static efficiency results that are central to the case for economic incentive instruments are a weak reed. Even in the context of industrialized countries, it is necessary to take account of:

- The high price of such achievement, in the general case, in terms of the knowledge and computing capability available to the environmental agency (or the complexity of the quasi-market setting that must be created).
- The lack of any second-best result guaranteeing that having some economic incentive in place is better than choosing some other regulatory path.
- The difficulties posed by the dynamic elements of the problem, such as inflation, and changes in industrial structure and in technology.

Second, when the choice setting is a developing country another concern, i.e., institutional capability, has to become central. Introducing and administering a system of regional or national environmental management based on one or another economic incentive instrument will never be institutionally easier than using one of the so-called "regulatory" approaches. In most cases, it will, in fact, be considerably more difficult.

Third, one of the central contentions of this report is that of all the possible criteria to apply in making a choice among instruments, the most important one for developing countries should be institutional compatibility. This is not to say that economic incentive instruments will never be appropriate in a developing country setting. But, as a general proposition, it is argued that they will be most appropriate for applications to problems and in situations that look most like the industrial world.

Fourth, as the last sentence implicitly recognizes, even within a single developing country, there are vast differences in problem types and institutional settings. Useful advice will necessarily be problem and setting specific. It will be unfortunate if a general but naive enthusiasm for economic incentives in environmental management leads to their adoption where they are inappropriate.

Structure of the Report

The report that follows is organized into five major sections. First, the instruments themselves are discussed, the initial goal being to change the terms of discourse by doing away with the misleading terminology of "command and control" as applyed to all instruments not explicitly involving prices or markets. Then, a range of instrument possibilities and their properties are discussed in both static and dynamic contexts. Along

the way, the possibilities for identifying a general second-best approach are assessed. (In this discussion the body of the text is supplemented by a more technical appendix.) The second section following the introduction returns to the theme of the institutional setting, with subsections on the public and on the private (or market) aspects of that setting.

The report then brings together the institutional and more narrowly economic material and attempts to offer general guidance on types of instruments that seem most promising in various combinations of circumstances (though there is no attempt to be exhaustive of all possible combinations). These recommendations are also contrasted with those from some other authors, to the extent that is possible. The penultimate section of the report contains summary material on efforts at environmental management in a few Latin American countries, especially on efforts to institute economic incentive systems. The concluding section contains both a summary of the major arguments and conclusions from earlier sections and some speculation about the possibilities for using environmental policy design as a way of influencing institutional evolution within developing countries.

Commentary
on Instruments of Environmental Policy

Before turning to the discussion of the properties of environmental policy instruments, it will be worthwhile to pause for a brief consideration of the policies themselves.

It is assumed in this report that every nation, no matter how poor, will find it in its own national interest to assert public control over some facets of the relation between its economy and natural environment. In the very poorest countries, these control efforts may be limited to the most immediately dangerous problems: for example, efforts to keep human wastes from entering drinking water supplies in order to break endemic disease cycles; bans on lead in gasoline to protect, especially, children; and the discouragement of rural deforestation to help maintain top soil, prevent siltation of downstream reservoirs, and reduce flood peaks. Exactly what policies and goals are pursued at different levels of per capita income and of development construed more generally will be determined by political decisions, informed to a greater or lesser extent by scientific, engineering, and economic analyses.

Many, if not most, economists would prefer to see the analysis of prospective environmental policies integrated in the benefit-cost framework as a way of checking on the economic rationality of the political decisions. Some smaller subset would want to make the benefit-cost analysis determinative, at least in the sense that a finding that benefits exceeded costs would be a necessary condition for policy approval. Indeed, the ultimate in economic analysis would integrate the choice of environmental goals (optimal ambient quality levels, for example) with the choice of instruments for their attainment.

The difference between this ideal and the working assumption for this report is justified on the basis of the following observations.

First, even in the United States, with its plethora of data and its demonstrated willingness to spend on environmental research, neither this kind of ultimate analysis nor even a requirement that regulations pass a benefit-cost test are found. What are found are requirements, so far in the form of Presidential Executive Orders, that benefit-cost analyses of proposed regulations *be done*, even where the underlying legislation guarantees that they will be disregarded in setting the standard. Further, while these analyses may or may not attempt to identify an optimal policy choice, they do not integrate the choice among alternative policy instruments.

Second, the estimation of damages from environmental insults (the benefits of removing or reducing the insults) is extraordinarily difficult and expensive to do in a persuasive way, even in industrial countries with a great deal of data in such related areas as public health, property values, outdoor recreation habits, and existing ambient environmental quality levels.

Third, it does not seem reasonable to expect that developing countries will find it worthwhile to do what major industrialized countries do not, especially so long as there remain prominent policy targets of the sort noted above. (See, for a parallel argument, Vaughan and Ardila, 1993.)

To say that cost-benefit analysis for choosing policies and policy instruments is not reasonably expectable in the Latin American context is not to say that industrial country policy choices (ambient quality targets, for example) should simply be imported. There is a *via media* open to these countries. They have access to information about the choices made by the industrial countries, the scientific (and often economic) rationales for those choices. They also have knowledge, even if not enough knowledge to quantify and monetize damages, of their own situations. This information may include public health statistics; the identity, location, and size in output terms of major industrial enterprises; land use in urban and rural areas; and tourist destinations and activities. Informal analysis

of the match between the imported targets and the domestic situation can be very instructive, suggesting where and even roughly by how much to relax, for the time being, the industrial country targets (see also Halter, 1991). It is also true that much available environmental control technology, such as wastewater and stack gas treatment options, are themselves adjustable. So that choosing a lower environmental quality target need not imply inventing an entirely new set of treatment processes. It may only involve adjusting, for example, the designed size and hence retention time in activated sludge wastewater treatment plants so as to give particular removal efficiencies for suspended solids and biochemical oxygen demand.

In short, this report does not advocate any particular set of choices for environmental policy targets in the Latin American settings. It does criticize the notion that economic incentive instruments of policy are the preferred choice for meeting whatever targets *are* chosen under any and all circumstances. Indeed, the argument will be that economists have seriously oversold the virtues of such instruments, especially the emission charges, independent of the setting. When the setting is a developing country with limited institutional capability, there are additional arguments against economic incentive (or "market-based") instruments.

But before getting into institutional matters, the report turns to the critique of the technical arguments for economic incentive instruments. Thus, the next subsection reconsiders the dichotomy, found in so much of the relevant literature, between "economic incentive (or market-based)" instruments and "command and control" instruments, where the latter are usually taken to be everything else. The second subsection examines the arguments about which instrument is to be preferred, critiquing along the way some common misperceptions and mis-statements in the literature. The content of this section is economic (*micro*economic, almost entirely) and the discussion is intended to put the prospects for economic incentives in perspective even before the central matter of institutional capability is considered. That matter is pursued in the following major section.

An Alternative Taxonomy of Environmental Policy Instruments

According to most of the economic literature on the instruments of environmental policy — certainly almost all of that referred to at the beginning of this report and meant to apply to developing countries— there are two types of instruments. The good ones are economic incentives (administered prices, as in emission charges; administered markets, as in tradeable permits). The bad instruments are called "command and control," and that phrase is often used as though it referred to every other possibility for government intervention.

Certainly "command and control" is meant to be pejorative, calling up the great failures of the "command" economics of the Communist bloc and implicitly contrasting "control" with "free" as in "free markets." But effective though this may be as a rhetorical device, it is not at all helpful in understanding the choices that are actually available to governments bent on intervening in the environment.

An effort to improve on the situation is summarized in Figure 1, which focuses on two characteristics of policy instruments: whether the instrument tells the parties subject to it *what* to achieve, and whether it tells those parties *how* to achieve it. Of the four possible instrument types identifiable under this simple scheme only one seems appropriately labeled "command and control:" that is, the instrument (or approach) type that tells regulated parties *both* what to achieve *and* how to achieve it. The examples suggest that command and control regulation really does go on, even when thus narrowly defined. But what seems far more important are two other observations:

Figure 1. Environmental Policy Instruments: An Alternative Taxonomy

	Specification of Goal or Objectives	
Specification of Implementation	Specifying **What** is to be Achieved by Regulated Party	**Not** Specifying What is to be Achieved by Regulated Party

Method		
Specifying **HOW**	Input, product, or practice ban. U.S. auto pollution control, with equipment requirements **and** discharge standards. Fishery management via catch limits **and** gear restrictions	Technology standards - pollution control equipment - fishery gear - BMP for agriculture - landfill construction rules Liability law **with** minimum standards of care
NOT Specifying How	Discharge Standard (tradeable or not) based on: - technology - AEQ - percentage reduction Limit on fish or game take per fisherman or hunter Limit on logs taken from a forest	Charge per unit of environmental insult - discharge - board feet - fish taken Provision of information - to public (TRI) - to polluters or farmers: technology transfer Overall limit on insult - AEQ Standard without further implementation effort - overall fishery limit Liability law **without** minimum standards of care Product taxes or Input taxes

Notes: AEQ=Ambient Environmental Quality; BMP=Best Management Practices; TRI=Toxic Release Inventory.

First, among the most widely used group of environmental policy instruments, especially numerical limits on discharges or resource harvests, most cannot usefully be thought of as command and control because they leave the "how" of compliance open. Indeed, the great variety of non-economic instruments of policy, and their corresponding variety of properties, is the strongest argument for going beyond the popular dichotomy.

Second, while most of the open-ended options (those that specify neither what nor how) are also from the economic or market-based incentive genre, not every open-ended option is economic nor is every one obviously desirable. Thus, the provision of information, either to the public or to "regulated" parties, is certainly open-ended. It may or may not be a desirable option, in any particular context. Indeed, very little is known about the actual effects of information provision let alone how to judge *a priori* how well it might perform in some new situation (Russell and Powell, 1994). There is firmer ground for judging a policy of just specifying the "required" ambient result (ambient air quality, hectares of forest remaining...) without telling the responsible parties (pollution dischargers, loggers...) what each is responsible for doing or paying. This approach is likely to produce *no* effect exactly because no enforceable rule or pricing regime is laid on any decision maker.

Thus, the relative desirability of choices from this particular instrument menu will be determined by many factors, only one of which will be the potential desirability of leaving choices to the regulated parties themselves.

Observations on Judging Among Instruments of Policy: Abstracting from Institutional Capacity

The aim of this is to clean up after some of the less careful analyses in the economics literature on instrument choice, especially for developing country settings. (Those interested or just skeptical will find support for the assertions that follow in the technical appendix, which extends the discussion found in Bohm and Russell, 1985.)[1] The four economic facets upon which the section concentrates are static efficiency and first-best results; second-best options; the importance of "mere" transfers; and dynamic considerations. Subsidies as a policy instrument are treated separately, in large part because of the importance of the element of transfer that they involve.

1 A review of recent thinking about a dozen candidate policy instruments in the U.S. context, in terms of their efficiency and "fairness" properties may be found in Russell and Powell, 1994.

Static Efficiency or First-Best Results

To a large extent economists, in their relation to static efficiency, are in something of the same position as the drunk who looks for his car keys under a street light because only there does he have a chance of seeing them. In an intrinsically dynamic world, in which short-run optimal decisions need not be dynamically optimal, making a great fuss over static optimality may well seem of limited usefulness. But it is done because only in that setting is there a credible and generally operational way of modeling the system so as to compare predictions with an efficiency benchmark. Thus, in the static principal-agent framework, it is possible to specify: the reward or penalty structure imposed by the principal; the options, and their costs, available to the agent to respond; and the presence of a monitoring and enforcement regime. Certain reward/penalty specifications can then be shown to lead to statically (socially) optimal behavior on the part of the agent.[2] When the dynamic box is opened, however, it is no longer possible to make a persuasive model of the options open to the agent and thus to society. Most obviously, it is not possible to model the induced technical change process believably in a way that produces a firm behavioral prediction. Thus, there is neither a dynamic benchmark (other than a tautological one of least present value of cost) nor any way of predicting agent behavior in the face of alternative penalty/reward specifications.

Within the static efficiency case two broad alternative assumptions exist. First, that marginal damages attributable to each party are known. And second, that the instruments are to be used to meet politically specified targets, so that marginal damages (or benefits) are irrelevant.

The first situation receives a surprising amount of attention in the literature. However, even though damage (benefit) estimation techniques are certainly improving, it is likely to be decades before politically persuasive estimates of the *marginal* damages attributable to each source are available from which to structure a so-called "Pigouvian charge" on units of environmental insults. Making this possibility a reason for taking economic incentives seriously borders on false advertising.

Even accepting the limitation to a static case and to a politically determined target (such as an ambient quality standard or a renewable resource harvest target) the conditions under which the least (social) cost solution results from the application of economic incentives are distressingly narrow and demanding. In particular, such a result will, except in special cases, require that the incentive be tailored to the situation of each individual regulated party. The tailoring process requires knowledge both of each party's cost function (for reducing its discharge or harvest) and the relative effectiveness of its reductions in improving ambient quality or reducing harvest. These latter pieces of information require an understanding of the natural system and its interaction with the activities of each regulated party. All this means that in the general case, appeals to trial and error as a way of finding the optimal incentive set are, again, false advertising. Optimality can only be identified by information (and computation) intensive modeling.

If optimal discharge standards are thought of as the solutions to the dual problem to that required to find optimal charges, a couple of other observations follow:

- If there are optimal charges there are also optimal standards, whatever they are called.

- Those standards will never in general coincide with the set of discharges that result from a marketable discharge permit scheme in which one price prevails for all source-by-source trades. But trying to rig the prices to take account of source-by-source differences promises to create an administrative nightmare. Zoned trading rules can only approximate the true optimum and will do so at a cost in reducing market sizes. It will be an empirical question

2 In most of the literature, it is implicitly assumed that sufficient monitoring is done at zero cost to make it worthwhile for each source to comply, that is, emit no more than it is permitted or pay an accurate charge bill. The definition of optimality itself becomes more problematic when there are many sources, costly monitoring, and where the sources can observe what happens to their fellows under the enforcement regime.

(in the sense that it will be necessary to model it to get an answer), how closely any proposed zone arrangement can get to an optimum.

Similar points are made by Tietenberg (1995). See also Stavins (1995) for a discussion of the influence of transaction costs in tradable permit schemes. The latter's results and conclusions are directly relevant to the institutional limitations discussed below.

What About Second Best?

Presented with the above intentionally discouraging observations about static efficiency, someone inclined to believe in economic incentives and market-based incentives might be tempted by the notion that some price must, at least, be better than no price. A uniform charge, though not statically optimal, might be better than an arbitrary discharge standard. Even an indirect charge (as in a tax on some input indirectly related to pollution via a production process), might be better than "command and control."

Unfortunately, though not surprisingly perhaps, given the general impossibility nature of the theorem of the second best, no results support this inclination, at least not in the static setting. This is not to say that a price (or tax) can never be better than a standard, but only to say that it will always depend on the specific parameters of the cost or production functions and the natural world setting in the case at hand. See, for example, Russell, 1986, who shows that in a setting of given ambient standards, whether a uniform percentage rollback of discharges or a uniform emission charge across dischargers is preferred depends on the characteristics of the region, as embodied in pollution transfer models, source sizes, relative marginal costs, and source locations relative to monitoring points. Also, Tietenberg (1995) offers a summary of modeling results (the closest thing to real empirical results that are available). The table (#1 on p. 100) shows that what Tietenberg calls command and control (roughly, discharge permits, sometimes based on rollback, sometimes with other bases) can be cheaper than tradable emission permits.

The Potential Importance of "Mere Transfers"

The static efficiency results for economic incentive instruments refer, of course, to resource costs. When economic incentives are used, other costs are involved for the regulated parties. With marketable permits distributed free, for existing sources those other costs exist in opportunity terms, not as out-of-pocket cash flows. But for emission charges there will be actual money changing hands from source to agency. The amounts involved can be enormous when the charge applies to every unit of discharge. For example, work on refinery and steel-mill pollution control in the 1970s suggested that, at least at that stage of the clean-up process, the charge payments could be as large as the costs of clean up themselves (Russell, 1973; Russell and Vaughan, 1976). For a similar result in a very different setting (the impact of a fertilizer tax designed to achieve particular reductions in application rates) see Quiroga et al, 1995.

This can be a half full or a half empty glass, depending on other assumptions. The optimistic and enthusiastic point to these payments as the source of the "double dividend." It is possible to use this revenue to reduce other taxes with larger dead-weight losses per dollar raised and thus to raise social welfare. Any welfare change from tax system revision would be in addition to that implied by the environmental improvement itself. (See Bohm, 1995, whose summary section attempts to clarify the discussion, by defining the conditions under which the double-dividend applies, and investigating whether that dividend can be large enough to make the environmental charge "costless.")

If one is skeptical of the possibility that other taxes will be reduced, enthusiasm for this new source of environmental funding has to be at least somewhat tempered by the realization that, to the regulated party (polluting firm, logger, fisherman) the cost of the "least cost" solution could be doubled, unless some other way of full or partial "recycling" can be arranged.[3] Even in the double dividend case,

3 Farrow (1995) suggests a "lump sum tax credit" based on some amount of discharge not subject to current control by the source. (He uses a "base year" quantity.) The same effect could be achieved by combining a standard and charge with the charge applying only to amounts discharged above the standard. Any such approach weakens the double dividend argument and reduces the incentive for the source to find ways of shifting down its marginal costs of discharge reduction.

there will be differential impacts across firms and regions in any but a most unlikely case, namely, that the sources of payments of the reduced taxes happen to mimic those for the new emission charge.

Dynamic Considerations

As already discussed, it is very difficult to say anything in the dynamic setting that is even remotely as satisfying as the static result for optimal charges. It is common, therefore, to fall back on partial and relative results, such as the simple demonstration that *cet. par.* the charge creates more of an incentive for seeking technological innovation of an environment-saving sort than does a standard of equivalent strictness (Bohm and Russell, 1985). It is important to remember that "more" does not necessarily equal "better" in this comparison.

It is also useful to think briefly about the dynamics of a marketable discharge permit system. In particular, note that whatever the path of permit price over time, and whatever this opportunity cost does to spur innovation by particular sources, the effect on total discharges is, by design, zero.[4] Only by active intervention to reduce the extant total of permits will total discharges fall. (This statement can easily be translated to apply to, say, marketable rights to take so many fish per season, or to cut so many trees, or apply so many pounds of pesticide or fertilizer to cropland.)

On another dynamic dimension (ability to adjust to exogenous change, such as in technology or price level) the apparent ordering of desirability as between charges and permits (tradeable or not) actually is reversed. Thus, as the world changes exogenously, charges must be adjusted by active intervention just to maintain whatever situation could be called the *status quo ante* in the environment. Permits that are not marketable will continue to mean the same thing in environmental terms no matter what the price level or state of technology, assuming no accommodation of growth in the set of sources. Marketable permits accommodate change by allowing for price changes that make the existing permit total just what sources wish to hold in the new situation. If new sources are accommodated, it is by old sources voluntarily cutting back. But under the charge system there is always the chance that over time total environmental impact will go down, while permits, in effect, enshrine some level of environmental insult.

There is, unfortunately, no way to put these two opposing properties on the same scale to weigh which is the more desirable. But keeping in mind that there is this opposition can help to temper enthusiasm for one or the other claimed advantage.

Table 1 summarizes the arguments from the above subsections and from the Appendix.

Subsidies: Economic Instruments with the Opposite Sign

The transfer payment aspect of emission charges provides an obvious opening for the consideration of subsidy instruments because all such instruments have an element of transfer in the opposite direction to the charge approach. But the variety of possible subsidies is wide, and the arguments for and against them sometimes are complex and often, in effect, dynamic, going well beyond the essentially political question of transfers.

As for variety, consider the following list of candidates:

- Subsidies paid per unit of an undesirable action that is *not* carried out (e.g.: per unit of potential pollution, as defined perhaps by a base period, that is not emitted in the current period).

- Subsidies paid per unit of a desirable action that *is* carried out (as when a refund is given to a person for returning

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(See next subsection.) It does, on the other hand, reduce the potential political objections to a charge.

4 It is interesting to observe, in this context, that the design of the currently operating U.S. system of marketable permits for SO_2 emission defines a permit in the first phase as the right to emit one ton—not, as most discussions of such schemes assume, as the right to emit one ton per period over some longer or shorter period. This timeless definition has created the option, which utilities are taking advantage of, of storing options for future use. This raises the specter of what might be called "temporal hot spots" (*Wall Street Journal* 1995a, 15 November).

a bottle or can or auto hulk to a designated place, or when a desirable input is subsidized to make it more attractive, as ozone instead of chlorine in water purification).[5]

- Subsidies that constitute repayment of investment costs (tax credits or grants for purchase or designated types of equipment).

- Subsidies for undertaking the search for environment saving technologies, whether in production or in subsequent waste stream treatment.

5 There is a clear symmetry between not doing something undesirable and doing something desirable in many settings. The distinction is drawn here because in some settings the decision makers can be different, as described below.

Clearly the first two varieties of subsidy, since they apply at the margin, create incentives that are in the short run symmetric with those flowing from per unit charges. The actor deciding whether to undertake the next unit of cleanup or to refrain from throwing away the next bottle, will face an opportunity cost per unit and rationally will equate, in the pollution control case, that marginal opportunity cost to the per unit subsidy. There are, however, two special problems with using per unit subsidies to encourage reductions in undesirable behavior.

First, it is difficult to define the base case from which reductions are desired in a way that does not lead to something like blackmail. Actual measurements of base-case pollution discharges are fine for existing sources, for example, but what is to be done about new sources?

Second, it is well established that subsidies, by lowering average costs to discharges, tend to increase the number of dischargers, reduce their scales below the efficient level for given technology, and thus may well increase the total pollution load if other policies are not added on to prevent it (Cropper and Oates, 1992).

On the other hand, there are two potentially large advantages to per unit subsidies for desirable actions, such as payments for returned bottles, auto hulks, lead/acid batteries, or barrels of spent solvent.

First, the use of the subsidy shifts the burden of proof from the agency that wants to discourage improper disposal to the possessor whom must, in effect, prove proper disposal to collect the subsidy (Russell, 1988).

Second, for many such items, the subsidy can be detached from original purchase so that the incentive for proper disposal (collection and return) can be decentralized. (A common sight in U.S. cities today is the obviously poor collector of improperly discarded aluminum cans—partial street cleaning at no cost to the local government.)[6]

6 The reader will sense here the possibility of going too far with such incentives. Empty bottle refunds could conceivably be set so high as to create an empty bottle industry. Car batteries might be worth enough to encourage their theft from parked cars; and so forth.

Subsidies that help firms, farms, or lower government jurisdictions pay the costs of environmental investments desired or required by national (or provincial) policies themselves come in several varieties. For example, equipment grants (as in the U.S. clean water program), payment of initial costs of agricultural or forestry land use changes (as tree planting or the establishment of stream-side buffer strips (Southgate, 1995; Niklitschek, 1995; Hueth, 1995), and tax credits (Jenkins and Lamech, 1994). This family of instruments has two major rationales:

- Where regulations exist and are enforced, subsidies defuse political opposition.

- Where desirable actions are not required, subsidies may make the difference between voluntary cooperation and refusal.

The list of potential problems and design concerns for such investment subsidies is very long (Jenkins and Lamech, 1994) because of the near certainty that they will distort incentives in ways that are difficult to control. But in their classic form, help with capital costs, the big problems are exactly that they favor equipment installation over operation, and that too much investment is likely to be done under their influence.

Subsidies for research and development of technology or operating techniques are in themselves generally favored by economists because of the public good nature of any knowledge produced (Hansen, 1995). Two sorts of doubts, one general and one specific to the developing country context, may be suggested, however. First, unless the larger system of regulation gives the potential users of new technology an incentive to adopt it, the development effort may be wasted. Such an incentive would exist with fixed permit terms if these could be met more cheaply; and would be stronger with a charge or marketable permit. But if the discharge standard is simply adjusted to fit the new capacity ("ratchetted down" is the phrase used in the U.S. context) one would expect little reason to pick up the new technology and good reason to concentrate on identifying its shortcomings. Second, unless there is reason to think that there is something very different about back-

ground conditions—as there might be in very poor rural areas, or high altitude regions—the search for home-grown ("appropriate") technology may not be a wise use of public money in developing countries. National pride apart, there is much to be said for taking advantage of the work already done in the industrial world. (Hansen, 1995, also emphasizes that subsidies are institutionally demanding and warns against their use in developing countries for this reason. This anticipates the next major section of this report.)

The Institutional Setting in Developing Countries

So far the report's discussion of environmental policy instruments has been somewhat abstract because it has concentrated on the strictly economic arguments. In effect, the institutional capacity required to put in place and operate any of the competing instruments has been assumed to exist in all countries. There has been discussion neither of the differential institutional demands posed by different candidate instruments nor of the actual institutional capacity to be found in developing countries, especially those in Latin America. In this section, the homogenizing assumption is relaxed and these institutional differences are explored. That exploration will involve separate subsections on public (governmental) and private (market) institutions. Nongovernmental organizations (NGOs) will be dealt with where their potential roles seem to come up most naturally.

Public Institutional Capabilities

Within the question of public sector capacity there are again two types of questions to consider. The first type is by its nature messy, politically delicate, and difficult to answer in straightforward legalistic or quantitative ways. These may be called the "awkward" questions. The second question type is cleaner and neater, involving documents, organization charts, and matters of legal reasoning. If the first set of questions produces answers that point to inadequacies there is little the outside world can do—even the multilateral aid agencies with their massive resources of money and expertise. If, however, any problems seem to be with the second set of questions, providing assistance is fairly straightforward. It is possible that institutional failures of the first sort are at least as common as those of the second sort; but institution-building assistance seems designed as though only a few documents and organizational arrangements need to be tidied up.

Some "Awkward" Questions

Most general and least easily answered is the question: Does the country have the political will to impose current costs, often concentrated on a few large enterprises or municipalities, in return for much more diffuse benefits, some of them postponed, and most of them not routinely monetized? Asking the question in these terms, however, might be said to betray a sort of democratic assumption, namely, that it makes sense to think of each country as operating under a process that reveals something that can reasonably be called a collective "will." But if the great mass of the population is not really consulted; if the country is an oligarchy run for the convenience and enrichment of the owners of industry and property; then this assumption will not be valid. As important, for the purposes of this discussion, such a government is unlikely to be environmentally activist. In voting democracies, in which legitimate governments peacefully succeed each other, the above question of political will has more meaning, but the answer may still be no. No one is obliged to believe the local version of the assertion that some environmental protection will always make sense. And believing it does require a certain amount of faith in complex chains of causality—as from more expensive, unleaded gasoline to better health, smarter children, and higher incomes.

A second question is: Even if the formal institutions of government seem to have opted for a considered environmental policy, are there informal and disruptive institutions that prevent full discussion, and effective action in environmental matters? These might operate by punishing individuals who speak out, by controlling neighborhoods or entire regions *de facto*, or simply by buying off the "legitimate" decision makers (e.g., the Colombian guerilla groups that range across the entire country. *Economist*, 1995).

The last possibility above suggests a third fundamental question: Is there an ethic of public service in the country that makes bureaucratic or legislative rent-seeking (corruption) something that must at least be covered up by the participants. Or is every public policy hostage to a culture of bribery or of nepotism? When corruption is endemic, again the formal arrangements written into laws and regulations, the sizes of fines or charges, the terms of permits, and even the requirements for

best management practices, may mean very little.

A final question is: What sort of information sources are accessible to the population? Are these sources free to report pollution incidents? To tell what is known about effects of the chronic exposures experienced by parts of the population? To reveal which organizations, public or private are responsible for the incidents and the chronic exposures and who stands to profit? Or do state censorship, strict libel laws, or more informal and violent sanctions keep the media tame?

If the answer to any of the above questions runs counter to the notion of a transparent, accountable governing structure, then environmental management, because of the incidence of its costs and benefits, is very likely to suffer along with other, analogous, programs such as rural health care and primary education. And such fundamental institutional problems are, unfortunately, far from rare in the world. Consider the characterization of "Third World Countries" in Ebisemju (1993) as displaying:

> *...a low level of awareness of the environmental hazards of modern, large-scale development projects, political instability, intense promotion of ethnic rather than national interests, pervasive corruption, and abuse of power...also lack of political will on the part of the government.*

In such situations the comparison of policy instruments on the basis of their efficiency properties may well seem beside the point. A prior pair of questions will be whether any serious policy can be said to exist and whether any policy instrument can operate in a predictable and consistent way. These questions are returned to in the section below on recommendations.

Something Easier: Legal Arrangements and Organizational Structure

Having the general political will and lacking powerful informal obstacles to imposing that will may be necessary conditions for sound environmental policy design, but they are by no means sufficient. To translate will into action on the ground requires writing detailed rules and regulations, (even when economic incentives are to be used); acquiring and deploying technical skills such as those for monitoring ambient conditions and the contributions to those conditions of regulated parties; coordinating the actions of different levels and sections of government—central and provincial; the environmental agency and the prosecutorial and judicial systems—and keeping records that document problems and progress and that can form a basis for new recommendations or mid-course corrections. Here are some questions that probe these areas of what might best be called formal institutional capacity.

First, and perhaps too obviously, do the necessary laws exist? For example, do laws exist covering the forms of pollution discharge, renewable resource damage and overharvesting that are to be policy targets? Do these laws make the connection between development projects (roads, dams, ports, power stations) and the environment? Are these laws internally consistent so that, for example, account is taken of the conservation of mass and energy in production and treatment processes? Are the laws enforceable in that they specify the duties that may be placed on private parties or subordinate government units?

A second set of questions involves the institutions of environmental management themselves. How unified or how fragmented is the structure that will turn the laws into specific rules (or economic incentives) and then enforce the rules (or collect the charges, or record the permit trades, or whatever)? There is nothing that says that success requires complete integration, but the realities of bureaucratic behavior are such that if, for example, air pollution control in urban areas is assigned to municipalities, while rules for gasoline composition are made by an energy agency or state oil company, and power stations are designed and built under the direction of a planning agency with no environmental remit, the results are likely to be less than satisfactory. A minimally promising structure would seem to be one in which there is a pollution control agency (with full sectoral and geographic coverage); a natural resource management agency; and some sort of coordinating body that brings these agencies together with the development planning agency. For discussions of inadequacies and recommendations for improvements in specific countries it is hard to imagine better sources than IDB documents themselves. Examples available to the authors of this paper included reports on:

- Bahamas (IDB, 1993a) discussing fragmentation and sheer lack of enforceable regulations and proposing to help develop a national commission that would in turn develop environmental policy as well as an environmental impact assessment system.

- Colombia (IDB, 1993b) concerning the strengthening of regional "corporations" responsible for natural resource management.

- El Salvador (IDB, 1993c) proposing both general (information and environmental assessment systems) and specific (waste water and solid waste regulations and pricing or incentive systems).

- Guatemala (IDB, 1992) proposing a program to strengthen the institutional capacity of the national environmental management agency (CONAMA) and its regional offices and to promote legal reform and regulatory redesign.

- Jamaica (Gottret et al, 1995) documenting the shortcomings of this country's existing system (inadequate rules and regulation, poor planning, inadequately defined property rights) and recommending an ambitious program of reform.[7]

The third test of capacity involves skills. Do the agencies have the skilled people available to implement the laws?[8] This means having everything from lawyers to write regulations to technical specialists in the field who can operate ambient quality and discharge monitoring equipment or interpret aerial photos for signs of over-harvest or slash and burn agricultural encroachment.[9] Given laws, institutional structure, and skills, it is still necessary for the system to be set up to ride herd on the details of implementation.[10] For example, if discharge standards are to be the enforceable duties laid on industry and municipalities, is there a system in place for writing them? Is it a system that guarantees consistency with whatever basis has been chosen for these standards, be it a simple percentage roll-back model, or an effort to meet given ambient quality targets at something approximating least cost? Is an effort made to do the necessary enforcing?[11]

Institutional Capabilities and Market Configurations in Latin America

The conventional arguments from static efficiency used to support MBIs rest upon a special or ideal view of interaction between private and public agents. In this model, economic transactions occur in perfectly competitive markets where firms maximize profits. The role of government is limited to that of fine tuner. Since the market can adequately maximize social welfare, any intervention beyond Pigouvian taxation imposes unnecessary costs on society.

Competitive markets and passive governments are not characteristic of Latin American

7 It is worth noting that several of these reports mention economic incentive policy instruments with approval (El Salvador, Guatemala, Jamaica in particular) though without any evidence that the documents' authors had considered the heavy institutional demands posed by use of such instruments.

8 Not surprisingly, the IDB is active in supporting, or proposing to support, training. For example: IDB 1992, 1993b, 1993c, and Gottret et al., 1995.

9 "In the field" is not used here casually. One of the common criticisms of developing country government structures is that they are so centralized that field assignments are looked on as career death sentences; and much effort goes into avoiding or cutting them short (Israel, 1987).

10 It is interesting to note that some observers seem to think that widespread use of personal computers, possible in developing countries because of price declines, can substitute for all manner of institution capability (e.g.: *Wall Street Journal*, 1995b).

11 Monitoring for continuing compliance is a big problem even in industrial nations (e.g.: Russell, 1990); and by the logic of the situation, it is difficult to determine how successful any effort is without essentially duplicating it. But anecdotal evidence, albeit for other social standards, suggests poor prospects in Latin America. See, for example, *Wall Street Journal*, 1995c, on labor law and agreement enforcement. More directly relevant are observations concerning lack of enforcement effort in Uruguay in Baker and McKenzie (undated, Vol. 3, No. 1), and Guatemala in Cutter Information Corporation (May 1995).

economies, however. The economic history of the region is better described in terms of state monopolies, distorted markets, and interventionist or *dirigiste* governments.[12] The good news is that the habit of over-regulation and over-centralization has recently begun to yield to a new wave of reform and restructuring actions that include privatization, market pricing, and removal of barriers to competition. With these reforms, markets in Latin America may evolve into those assumed in theory. When this occurs, MBIs may be able to reach their potential for inducing cost-effective policy through market manipulation because firm owners, farmers, and industrial managers will have become skilled in responding to market signals rather than at lobbying government sources of privilege and cash.

Admittedly, there is no general relation that says environmental policies can only work in competitive settings. Indeed, the recommendations made below rely on the notion that competent government can achieve much via such instruments as product or process specification, specific technology requirements, and performance standards (as for discharges) that lack a marketability dimension. But when policy instruments involve administered prices or created markets, the general level of private sector skill does become an issue. A low level of skill will at least make it unlikely that the potential efficiency gains of the instrument will be realized. At worst, one could see an entire line of policy development discredited through, for example, widespread business failures.

The choice of environmental policy instruments may, therefore, usefully be thought about in terms of matching the evolution of instruments to the evolution of private institutions. A basis for discussing such evolution is provided by the notion of market (and non-market) "configurations" developed by Thorbecke, 1993. A configuration is defined principally by market structure but also reflects the non-market relationships among households, the government, and the productive enterprises, be they private firms or appendages of the government. Such relationships include both current rules, such as those involving enforcement of contracts, and expectations, such as whether or not the government will rescue a failed private enterprise.

Discussion of environmental policy in Latin America involves considering two configuration trajectories. The first describes the path of industrial and commercial development usually in urban settings. This development is linked to problems of air quality, sanitation, and solid waste management that plague most Latin American cities. The second trajectory describes the unique path of rural markets. The pattern of land tenure, the extent of rural poverty, and the importance of export production determine configurations within the agricultural economy, and therefore will influence which environmental policies seem most promising at a particular time.

Industrial and Commercial Configurations

Between the Second World War and the early nineties, Latin America followed a strategy of import substituting industrialization (ISI). Intense government intervention protected state-run monopolies with price controls and import taxes. This approach produced unbalanced growth in inefficient industries, and its short-lived success relied almost entirely on government engineering of relative prices (Cammack, 1992). As noted above, ISI had its roots in a long tradition of symbiosis between state and enterprise that traced itself back to Spanish colonial policy. In the Spanish system, the state had preeminent domain over resources and production. Property rights were seen as a political instead of contractual creation. Therefore, the state instead of the market was seen as the principal mediator of ownership transfer. Informal market configurations developed parallel to state monopoly configurations, however. ISI in Latin American countries generally concentrated development in one or two major cities. Growth in the urban sector led to massive migration from the rural areas. Formal labor markets in the cities only absorbed a small portion of these migrants (Syrguin, 1991). Unemployed and underemployed households settled in shantytowns on the urban periphery. In order to generate subsistence income, households established small enterprises that were unregulated and often illegal. When government controls cause significant distortions in market prices, as ISI commonly did, opportunities exist for those who can escape bureaucratic scrutiny and sell goods or services

12 For a current assessment along these lines see *Wall Street Journal*, 1995d, describing overcontrol in Venezuela. For a literary but telling version of this diagnosis see Naipaul, 1995.

at something closer to a free market price. The informal sector in Latin America filled this niche effectively, and in some cases, developed new microindustries (Portes and Schauffler, 1993).

The duality of state monopolies and unregulated informal market industries creates two distinct environments for the implementation of pollution reduction policy. In state monopoly configurations, the regulatory agency typically faces a small number of polluters concentrated mostly in industrial areas. A small number of potential polluters can mean it is easier to link environmental insults with their sources. However, with the market concentration enjoyed by monopolies typically comes significant political strength; and in this case, the monopolies were often part of the government itself. Political opposition can mute efforts to enforce "official" environmental statutes.

Informal market configurations create different challenges for environmental policy. Since the informal sector is comprised of numerous microindustries, production, and therefore pollution creation, is highly decentralized (Fuhr, 1993). It is also often concealed, insofar as possible, because of its illegality. These features make it difficult to pinpoint polluters. Unlike the state monopolies, these industries, because of their small size, rarely have sufficient political capital to challenge the authority of the regulatory agency. While the power of the agency can go uncontested, the limited financial resources of these industries restricts the set of environmental improvements that can be mandated without public subsidy. And the sheer numbers make it impractical to think of standards or charges tailored to the situation of the individual firm. Easily monitored requirements applying very broadly are much more likely to be practical.

By the late 1980s a variety of forces had pushed several Latin American countries into moves designed to change this "traditional" configuration, in particular its reliance on state monopoly as the form of organization for the production of goods and services (Ocampo, 1991; Boeker, 1993).

Sometimes private monopolies were used as intermediate steps toward competition. For example, *Teléfonos de Mexico* was granted a six year monopoly so that it could expand service without threats from long distance competitors. After six years, though, no protection from competition was guaranteed (Sánchez et. al., 1993). Temporary monopolies were also granted in Argentina's privatization of *Empresa Nacional de Telecomuni-caciones*. The state's telecommunication conglomerate was split geographically into two corporations to foster an immediate "competition by comparison" between two private monopolies. This, it was claimed, would enhance a competitive spirit already created by uncertainty of continued monopoly status (Gerchunoff and Coloma, 1993). But vestiges of the economic culture dominated by state intervention remained. Producers still expected public agencies to bail them out of bad business decisions; and government bureaucrats continued to be pessimistic about the ability of unregulated markets to produce economic improvements (Martin, 1988).[13] Nonetheless, when markets move beyond monopoly to display some level of competition, they are said to enter a transitional configuration. Within this configuration, prices tend to move freely, production is typically less centralized, and global markets exert some unregulated influence.

As mentioned before, the theoretical endpoint of market development and the restructuring process is seen as a mature competitive configuration. In this configuration, government ownership of production capital is very small, and private firms survive internal and external competition without government support or protection. Entrepreneurship drives innovation, and market entry and exit are fluid. Market prices reflect the marginal costs of production. These are institutional market characteristics that are theoretically necessary for the successful operation of MBIs. However, since most of Latin America began restructuring in the late eighties and early nineties, the region offers few examples of this configuration.[14] For

13 Gerchunoff and Torre, 1992, have noted that while there are Latin examples of entrepreneurial development independent of the public sector, such as in Chile and Brazil, there is still significant demand for public intervention: "Latin American economies continue to be mixed, developing, and unstable. The public sector is still asked to participate in investment and production; it is still asked to satisfy the demands for a farther-reaching social policy and more efficient public services." (p. 272) See also, on Brazil, Werneck, 1991.

14 Chile spearheaded privatization and deregulation in the

most industries and governments it is a goal for the future, though whether it is ever even approximated will depend on currently unknowable political forces and events (Burchand Braga, 1993).

Rural Configurations

Whereas restructuring has produced some growth and competition in Latin American industrial and commercial markets, rural institutions have experienced little change. This is consistent with the area's history of static economic structure outside of urban areas. There are two reasons for this rural inertia. First, agriculture has not often been seen as a sector that sustained significant growth for a developing economy, and it therefore has not been a priority in development policy (Janvry and Sadoulet, 1993). Preoccupation with ISI following the Second World War and with privatization in the late eighties reflected this bias. With less public attention and fewer resources, agriculture was not even as dynamic as industry or commerce. (For a general, continent-wide, discussion, see Garrett, 1995.) Second, because of a strong centralist tradition in Latin America, institutions at lower jurisdictional levels outside of large urban areas are inadequate in their representation of rural community concerns and their ability to administer public policy (Ortega, 1992). This void in local leadership weakens the ability of policy actors to improve economic performance in rural areas.

Rural production is divided between *latifundios* and *minifundios*. *Latifundios* are large estates that specialize in commercial agricultural production. These configurations sometimes comprise as little as ten percent of all farm units (Guatemala, Ecuador, and Peru), but they typically control fifty to eighty percent of the land, using it for the large scale production of primary exports (Forster, 1992). There exists an historical alliance between *latifundios* and the central government so that, to the extent Latin American governments have taken an interest in agriculture, at all, they have worked with *latifundios* to develop the capacity of agriculture to earn foreign exchange. This alliance gives the *latifundios* significant political power which logically contributes to the previously mentioned weakness in independent municipal institutions in rural areas (Ortega, 1992).

On land not controlled by *latifundios*, poor rural households, or *minifundios*, engage in subsistence and small-scale commercial agriculture and sell labor to larger estates. These households typically crowd marginal land at the periphery of *latifundios*, and sometimes their production is not even enough to meet basic needs (Ortega, 1992). Reform in the 1960s and 1970s transferred more land to *minifundio* control, but it did little to raise per capita output on these holdings above subsistence (Forster, 1992). The role of government has always been limited in the minifundio context. Since *latifundios* dominate the political process, they typically siphon available public resources for their own development. This hinders integration of small farmers into the market process (Gligo, 1980).

In the context of land and resource policy, government interaction with *latifundios* will contrast with the interaction with *minifundios*. A lot of land concentrated in a handful of *latifundio* owners creates a situation paralleling that described for state and private monopolies in industry, and exhibits similar advantages and disadvantages for environmental agencies. If there is cooperation between the agency and the *latifundios*, then the costs of negotiating initiatives in forest management, soil conservation, and nonpoint source pollution control can be low because in order to manage large tracts of land, the government only has to deal with a small number of private decisionmakers. Cooperation, of course, may be hard to achieve due to the history of

region and today offers some examples of healthy competitive markets (Hojman, 1993). In Santiago and other large cities, municipal transportation was deregulated in 1980. With the disappearance of price controls, fares rose and converged across different transportation modes (buses, mini-buses, taxis, etc.) in instances where these provided similar service. The quality of service improved, and most importantly, competition between a large group of private carriers was sustained (Thomson, 1992). A year previous to transport deregulation was the privatization of *Celulosa Arauco* and *Celulosa Constitución*, two firms involved in industrial timber. This removed the state completely from an industry that already had little regulation. With competition and openness to external trade, timber price and production were determined by the market (Hachette et. al., 1993). At the other end of the institutional scale, Bolivia is selling off state firms and putting the proceeds in retirement accounts for its citizens (*Wall Street Journal*, 1995e).

effectively unchallenged political power wielded by *latifundios* in the rural areas. Policies that require *latifundio* owners to answer to newly formed environmental agencies may, indeed, be extremely hard to implement.

Minifundios may not have the political power to raise the transaction costs of imposing regulations, but they still present two important challenges to the effectiveness of land management policy. First, many poor rural farmers occupying marginal land and producing just enough to meet basic subsistence needs, typically face few alternative farming strategies that can decrease land degradation without decreasing food output. Even if such alternatives do exist, policy makers must overcome the second challenge of limited rural knowledge. Few minifundio owners know even simple strategies for commercial agriculture and livestock management that minimize agricultural runoff. Governments will have to surmount this obstacle before even BMP (technology specification) policies can successfully be implemented.

Some Recommendations about Environmental Policy Instruments and their Evolution

Bringing together the economic cautions from the section of "commentary" on the instruments and the institutional discussion of the previous section permits an attempt to provide some prescriptions, though this is done with a *caveat* and an apology. The *caveat* is one already noted—that really useful advice will be situation specific. The apology is for the apparent arrogance of nonetheless presuming to advise from a distance and in the abstract.

However, to set the stage, it is first assumed that the "awkward" questions asked in the previous section have reassuring answers. That is: The phrase "political will" has meaning beyond referring to the desires of an autocrat or oligarchy. That will embraces some level of environmental effort. There are no insurmountable problems posed by parallel, informal institutions bent on frustrating the legitimate authorities. The public service ethic is at least strong enough that inevitable efforts at personal enrichment must be concealed from public view, because there is a price to be paid for discovered corruption. And there is at least some approximation to a free and critical press (referring to all mass media, not newspapers alone). This situation seems to be the one assumed for the "institution building" activities of the IDB (Brañes, 1991; IDB 1992, 1993a, 1993b, 1993c; Gottret et al, 1995).

The key questions under these general conditions concern the capabilities of the legitimate government institutions, and the current and aimed-for configurations of the commercial/industrial and rural sectors. Of the very large number of possible combinations of specific conditions in these sectors, this report concentrates on three. These are labeled "traditional," "transitional," and "modern." The features ascribed to each sector in each setting are summarized in Table 2, where the reader will see that a roughly consistent path of evolution for each of the three sectors is assumed. That is, as formal government organization improves, so do the available skills and information and so does the revenue-raising capacity of the public sector. Correspondingly, the enterprise sector is also advancing toward large numbers of competing firms and facing less intrusive economic regulation; and in the rural areas latifundios are becoming skillful global competitors, while subsistence farmers are transforming themselves (with help on the technical and credit fronts) into producers of cash crops for local and regional markets.

To parallel these settings this report recommends an evolution of instruments from the most easily defined and enforced, and the least closely connected to ambient quality goals; toward those involving more difficult definition tasks and closer connections to desired ambient results, aiming at tradable permits in the long run. Such an evolution is set out in Table 3, for the three institutional settings and three problem types: pollution control, agriculture, and renewable resource management (forestry and fisheries principally).

Thus, in the traditional setting the emphasis is on simplicity of demands on both government and the regulated parties, and the specification of technology figures large. The advantages of this approach lie in the type and source of the information required (modification, as proposed by Halter (1991), for example, of the technology already developed by industrial countries), and monitoring. While installation does not guarantee operation, at least it is possible more easily to begin establishing norms of compliance when what is at issue is the presence or absence of pieces of equipment. There is no link required to any particular ambient quality (or fish population or rate of timber harvest).

This last feature is, of course, a double-edged sword. It greatly simplifies the government agency's definition problem, and that is one justification for using these instruments here. But it also makes discussion of static economic efficiency beside the point. Said another way, the target proposed here is the technology itself. Some improvement in ambient quality will follow (unless the specification process goes horribly wrong). But once it is known what that improvement amounts to, it would (almost) always be possible to specify another route to its

achievement that would be cheaper. One other danger exists: that these technology specifications will become frozen through political paralysis. The report's recommendations assume that antidotes are available for this disease, and that evolution of goals and techniques will be possible as well as desirable.

One final note on the traditional-phase instruments: charges are proposed in a few very simply organized and monitored settings. For example, if a public agency builds a wastewater treatment plant and requires that local industries be connected to it via sewers, it becomes quite straightforward to calculate a cost-recovering charge per unit of contribution to the plant's load.[15] In addition, as long as the sewering requirement is enforced, the accurate metering of the charged components of source contributions is itself quite straightforward for industrial users. (Whether domestic dischargers are, or are not charged in any way approximating a per unit charge will, as a practical matter, depend on whether their water use is metered. If it is, a waste water treatment charge can be added to the water bill, again using well-established formulae.)

In the transition phase of institutional evolution, the array of potential useful policy instruments grows wider. In the pollution control area, the responsible agency may move first from technology specification to technology-based permits, as used, for example, in the U.S. Clean Water Act system. These permits do not require installation of any particular technology, but rather require each source to achieve what it is calculated *could be* achieved by installation of a technology defined by its relation to the state of the art, using such phrases as "best available technology," or "reasonably available control technology." Such permits could become the basis for a tradable permit system in the next institutional phase.

It is important to note once again that the connection between these permit terms and ambient quality is, in effect, the reverse of what is required for any claim of efficiency. That is, the technology-based permits will, if enforced, result in some level of ambient quality. But except by the luckiest sort of accident, it would never be cheapest to achieve that ambient quality, considered now as a target, by imposing the particular set of permits implied by the technology definitions. Once again, the report's recommendation is based on the judgment that the scarce resources of most concern here are related to institutional capacity —available information and computation sophistication capacity. (The monitoring problem for a technology-based permit system is the same as that for any other system in which quantities of pollution discharge per unit time must be checked up on, whether that system involves ambient quality-based permits, tradable permits, or emission charges.)

In the agricultural sector, the major instrument recommendations for the transition setting are roughly more of the same as for the traditional —best management practices— with the introduction of environmentally justified taxes on polluting inputs (Quiroga et al, 1995). For fishery and forestry management, the transition setting is the time to begin using more difficult to monitor instruments, such as permits to cut so many board feet on so many hectares; or to catch so many tonnes of particular fish species over specified periods. (Such requirements are clearly the analogs to discharge permits expressed in weight of pollutant per unit time. The reason for avoiding such permit types in agriculture is the monitoring problem for nonpoint sources, a problem that has not yet been solved satisfactorily in the industrial world.)

Note also that as the transition toward the modern setting proceeds, experiments and demonstrations may be carried out in all the sectors. Examples include adding taxes on polluting inputs (Dessus et al, 1994 try to identify such inputs) and introducing stumpage fees in forestry and catch landing fees for fisheries. One other possibility in this regard is "challenge regulation." In this technique regulated parties are challenged to do better than the current requirements in return for a promised reward under the anticipated (threatened) next phase regulatory regime.[16]

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15 To say that this is a straightforward task is to say that there are well-established formulae available (Russell et al., 1990). It is not to say that these formulae solve the fundamentally unsolvable problems of joint cost allocation over the hydraulic and pollutant load components.

16 This is the basis of USEPA's "30/50" program on toxic emissions. See, for example, Arora and Cason, 1995. Note that for challenge regulation to be effective in the

(For example, go to 70 percent discharge reduction now instead of staying at 50 percent in return for a postponement of the new requirement to go to 90 percent, anticipated in 5 years.)

In the modern setting the instrument of choice for this report is some version of a marketable permit —to discharge a pollutant, to apply fertilizer or pesticide in agriculture, or to take fish or cut trees. The rationale for this choice —the determining property of the instrument — is flexibility on the face of exogenous change. As pointed out above, this flexibility reduces the recurring computational and political burden on the regulatory agency because it does not have to readjust permit terms or charge levels just to maintain some required ambient result.[17] (See also Lyon, 1989.)

Once again it is necessary to point out that where location matters, a simple tradable discharge permit system will not, except by lucky accident, produce the lowest cost allocation of discharges consistent with a given ambient quality standard. The dynamic property of flexibility (or self-adjustment) seems worth trading off what would necessarily be a temporary cost advantage. Where location does not matter, as it often does not with fish catches, static efficiency will accompany flexibility. The forestry case might go either way, but the ambient effects of agricultural input application will almost always be location sensitive.

The tradable rights notion brings up a facet of political and social organization about which little has so far been said: the courts and their role in private dispute resolution.[18] Thus, for example, one extension of the notion of "rights" creation could be over time so that, for example, a defined group of fishermen would be made "owners" of a defined fishery resource (a particular species in a particular location) in perpetuity. This could allow government to avoid specifying allowable annual harvests. But if such arrangements are to survive, the group must be able to make and enforce (through courts) rules for what is now a common property resource rather than an open access one.

From rights that operate over time in a narrow resource context it is another leap, and in some ways a very large one, to liability rules. These create particular rights for affected populations to be compensated for certain kinds of harm.[19] Enforcement of those rights in the environmental area involves difficult matters of proof and valuation. (See, for example, Dewees, 1992; and Russell and Powell, 1994.) This seems the most institutionally demanding way of attempting to affect environmental quality, and it is not recommended, even in the modern phase of institutional evolution (though this is also partly because its efficiency properties are much attenuated in real situations of multiple victims and sources of harm (Russell and Powell, 1994).

Finally, in the modern phase, the government will be in a position to experiment with the provision of information to the public, as is now done in the U.S. with the Toxic Release Inventory (TRI). It appears that this instrument can have powerful effects, particularly where there are environmental NGOs and a vigorous, free press ready and more than willing to amplify the message that some firm is the worst source of toxics in the country or region (Russell and Powell, 1994).

The report now backtracks a substantial way and considers what, if any options exist when the "awkward" questions of the institutional

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long run the government must remain credible, both as regards the later arrival of stricter standards *and* the exemption for those who meet the challenge from those later standards.

17 The problem of spatial hot spots will remain for pollutant discharge systems, however. A practical, if computationally intensive and bureaucratically annoying way to keep an element of control is to certify a regional air quality model as official and to require that all proposed trades be "run through" the model and produce no ambient quality violations. This could be done by consulting engineers, in-house by each party to the trade, or by the agency. (See the concluding section.)

18 For the enforcement of regulations, such as those requiring technology installation, administrative bodies may be sufficient to hear evidence of violations and assign fines. If criminal violations are created, as they have been in certain areas of U.S. environmental law, courts will probably have to be the venue for trial.

19 The enforcement of this general right is effectively in the hands of those who suffer, or claim to suffer, a violation of their right.

section do not all have good answers. For example, assume that an hypothetical country's leadership has decided that environmental conditions do demand improvement, so there is at least the minimum necessary political will. But further assume lack of full control over what goes on in the countryside, a bureaucratic "ethic" that institutionalizes corruption, and a press that is under the thumb of the ruling group. These are grave obstacles to effective action, even granting the assumption that some action is desired.

- Lack of full control of parts of the nation make field work and monitoring difficult or impossible, so that putting out information or checking on compliance with regulations or best management practices may be possible only in urban areas.

- Pervasive corruption means that payments to or from the government can too easily be turned into rent payments to agency "landlords."

- A controlled press implies that efforts to use information provision as a tool will not be pursued because of the open-ended and uncontrollable nature of the potential effects.

What to do? Two possibilities are: first, direct government investment in pollution control facilities; and, second, application of technology or technology-based standards to sources of urban water and air pollution. These could actually be enforceable and would offer relatively small or at least inconvenient opportunities for bribery. Beyond this, very few notions sound promising. For example, even technical assistance, coupled with challenge regulation, with the implicit threat being the arrival of a new regime with a more serious commitment to good administration generally seems problematic because of a credibility gap. While a new regime may be considered unlikely, any one that does replace the status quo may also be unlikely to honor the promise part of the challenge. On the other hand, technical assistance can at least be based on internationally available knowledge and involves small opportunity for corruption unless adoption of new technology is subsidized — something that would seem unwise in these circumstances.

It may also be tempting to think about attacking imported environmental problems, such as pesticides or solvents might be in a developing country. This could be sold as an exercise in regaining sovereignty. But it is not clear that in general much could be gained that way, both because the purposes served by the imports will usually have to be accomplished in any case; and because smuggling or illegal internal production may simply provide a new source of revenue to the informal challengers of government authority.

Some Comparisons of the Above Recommendations with Those of Other Commentators: Concentrating on Pollution Control

This report might be said to have two themes:

- Independent of setting, enthusiasm for economic incentives (or "market-based") instruments on the basis of their static efficiency properties, as commonly understood, is overdone.
- Especially in the developing country setting, consideration of the differential institutional demands implied by environmental policy instruments is key to wise choice.

It is possible that these themes in fact make little difference; that, when it comes to specific recommendations, everyone who chances them comes out in the same place. This would be surprising —perhaps disappointing to the reader who tends to agree with the themes, while comforting to those skeptical of the above arguments. It is therefore worthwhile to examine this possibility by comparing the recommendations of the previous subsection with those made by others. Unfortunately, it is not possible to be as comprehensive as one could desire in this matter; though some of the reasons for this are themselves interesting. For example, it is common for authors to combine enthusiastic discussions of economic incentive approaches with surprisingly unspecific suggestions about what to do (Panayotou, 1994; Gandhi and McMorran, 1995). This discretion may be the better part of valor, but it makes the task of comparison harder. Others (Bruce and Ellis, 1993), make some quite specific suggestions, but these do not add up to even modestly comprehensive policy recommendations. Yet others are both fairly specific and

fairly comprehensive (Business Council for Sustainable Development in Latin American (BCSD), 1995; and Hansen, 1995), but do not explicitly recognize differences in institutional capabilities and their possible implications for instrument choice and thus do not differentiate across country types or development stages. Those that do seem to take the institutional limitations seriously (Eskeland and Jiminez, 1992), are prudently cautious about specific recommendations.

There is also a problem of terminology. This is especially a problem when it comes to the area of "standards." In this literature, "performance standards" sometimes is the label for technology-based standards; sometimes it seems to equal "ambient-quality-based standards." Sometimes performance standards are different from "permits" (a word that sometimes itself seems to imply marketability) and sometimes not.
Finally, there is just a vast difference in how many sorts of instruments are considered. Some authors mention very few in their specific recommendations (Eskeland and Jiminez, 1992). Others confine themselves to half a dozen or so (Anderson, 1990; Business Council for Sustainable Development, 1995). While Hansen provides at least the basis for rating over a dozen.

These difficulties, though substantial, do not completely rule out comparisons, and this subsection discusses the assumptions and methods used to construct a table comparing the recommendations of this report with those that are explicit (or seem to be implicit) in six other reports. (Of the candidates referred to above, only Bruce and Ellis, 1993, is dropped. This is done because, while they make some quite specific suggestions, no ranking across instrument types could be discerned.) To accomplish even this rough comparison some fairly drastic steps have been taken. These include the following:

- The number of candidate instruments has been reduced to six from the 21 that constitute the union of the sets of possibilities mentioned by all seven reports. This forces the throwing away of information on fifteen instruments; but most of these are mentioned only by one or two of the full set of seven reports. (When a report has (implicitly) ranked 13 instruments as Hansen has, and only six of these are included, the order is maintained in this comparison but the numbering is truncated. Thus, if Hansen implicitly ranks the one of the six instruments seventh in his list, but it is third in the truncated list, it is shown as his third choice in the table that follows.)

- In the case of Anderson, Business Council for Sustainable Development, and Hansen, arbitrary (but not outrageous) scoring schemes were devised to translate their tabular materials on applications (Anderson) or properties (BCSD and Hansen) into summary numbers that allow ranking.[20]

- For the other three reports only rankings that seemed to be clear in the texts were included. Others, including the authors, might disagree with the readings here.

- The rankings in this report are dependent on institutional setting and are firmest at either end of the scale (best and worst). Accordingly, three sets of ranks, one for each institutional setting, are included here. But the reader is warned that the difference between a 3 and a 4 should not be given too much weight.

The results of these exercises are presented in Table 4. Unfortunately, there are many blank cells. But the pattern of the discernible ranks has at least two features worth special note:

- There is substantial agreement among the other reports on the high desirability of charges per unit of pollution. This is the clearest difference from this report.

- There is only slightly less agreement on

20 For Anderson preference was equated to frequency of suggested application to the fifteen problems in his Table 7 that are similar to the concerns in this report. Thus, a tool he considered applicable to 12 of 15 problems was taken to be preferred to one he considered applicable to 9 or to 5 problems. Clearly this is a leap since it penalizes what could be the perfect (or only) instrument for a special problem because it is not useful to several other problems. For both BCSD and Hansen a 3-alternative scoring system was devised with 3 for the best rank on a criterion and one for the worst, using the material they present in Tables 3.2 and on pp. 69, 70 (no number) respectively.

the wisdom of using "second-best" taxes per unit of input or output. Again, this report disagrees, though it becomes more favorable as the setting becomes more modern.

On other points the record is more mixed. Hansen and BCSD like marketable permits, while Anderson does not, and this report recommends them only as the setting becomes more nearly modern. In the most challenging development setting, the traditional, this report opts for technology specifications, moving to discharge standards, more or less whatever their basis as transition occurs. This looks more like Anderson than any of the others. Overall, in fact, there appears to be more common ground between this and Anderson than with any of the other reports. (This could be an artifact of the way his applicability judgments were used, however. Recall that he did not provide an explicit ranking.)

One final lesson from this table is that environmental policy makers in a developing country will have someone on their side almost no matter what they decide to do. Instead of the infamous two-handed economist, they are presented with a veritable Asian god with six, eight, or a dozen arms from which they must choose one applicable to their particular problem setting. The next section explores very briefly what choices Latin American countries have been making, even without the benefit of Table 4.

Some Evidence on the Actual Choices of Environmental Policy Instruments Being Made in Latin America

Keeping up with evolving environmental policies (and attendant instrument choices) in the 25 countries that are members of the Inter-American Development Bank would be a full-time job even if this was only done in a formalistic way. If one wanted to know how the language of laws, regulations, and court decisions translated into action, the task would become truly immense. In the circumstances, to pretend to completeness in this section would be foolhardy. On the other hand, there is some point in bringing together in one place what has been learned from a variety of sources, even if this compilation must be seen as the basis for a longer term effort to keep roughly up to date. This compendium will allow a first, very rough, cut at comparing actual policy choices with the recommendations commonly found in the literature.

Accordingly, a table of experience has been constructed from a variety of mostly contemporaneous sources of policy news and institutional commentary, and summarizes what has been learned about the adoption of 13 policy instruments in Latin America. (The first six of these match those in Table 4.) The arrangement of the countries in the table is, however, worth some comment and explanation. To make the table useful, especially in the context of this report, with its emphasis on institutional capacity, it would be desirable to arrange the countries in an order that parallels the traditional/ transitional/modern categorization. Unfortunately given the massive simplification effort lying between those categories and the multiple dimensions inherent in the notion of institutional capacity, there is no perfect ranking of countries for this purpose. Instead there are many possible different imperfect ordering systems; from the UNDP's *Human Development Index*, to the IDB's country groups used for project lending share allocations, to a ranking based on IDB staff perceptions of country environmental capacity and problems (Dourojeanni, 1994). Putting these three together leads to Table 5, the last column of which lists a composite classification using the same labels as the text proper: traditional, transitional, and modern.[21] Table 6 reports the information about country choices of policy instrument with the countries grouped according to the Table 5 result.

What expectations might one have *a priori* for this table? If the region's policymakers have been reading the literature cited here on

21 This composite represents the authors' informal combination of the implications of the other three rankings, with the internal Bank perceptions weighted most heavily. The Bahamas and Barbados are not in the table but are listed as transitional.

development and environment, the expectation would be for economic instruments to appeal to each group. If this report is actually tapping an existing vein of skepticism, then those instruments might be found only in the "modern" countries.

The table shows more evidence of adoption of eco-nomic instruments by the modern and transitional countries. But it is impossible to tell whether these countries actually adopt them more or they simply are the ones covered well by the available sources of information. The other side of this coin is that these two groups of countries do more of everything, experimenting with a range of instruments, not confining themselves to economic ones. The traditional countries do (or are reported to do) very little. It may be that these nations are waiting for ideas likely to work in their institutional situations. Or, they may be suffering from the maladies probed by the "awkward" questions of the institutional section. Or, possibly the compilers of tables and newsletters may simply not pay any attention to whatever it is that these countries do. Some of each would be a reasonable bet.

Concluding Comments

Economic incentive instruments for environmental management, like all real-world alternatives for intervening in markets for public purposes, have both advantages and disadvantages. The most significant of the former relate to dynamics:

- Charges on every unit of an environmental insult create the largest incentive among the available alternatives to search for less polluting technology.[22]
- Marketable permits self-adjust to exogenous growth and change.[23]

The disadvantages of these instruments revolve around what might be called their information intensity. This intensity is greatest when an effort is made to achieve static economic efficiency. Either a charge system must be tailored by the agency to the circumstances (costs, discharges, location) of each source; or an ambient quality permit system must be adopted, requiring sources to do and keep updated quite complex modeling calculations to determine the desirability of purchases or sales. It is much simpler to institute a uniform charge (or its dual, the straightforward, tradable discharge permit system), but there is no reason to expect such a choice to lead to lower cost of meeting a given ambient quality target than would some other quite arbitrary regulatory scheme.

If one believes that institutional capacity is likely to be among the scarcest resources in developing countries, there would seem to be good reason to seek less institutionally demanding approaches, recognizing that there will be other costs to taking these routes. Very roughly, this report suggests that countries with the least sophisticated institutions (both government and market) should begin by focusing on technology. This allows the importation from the industrial world of directly useful knowledge (but does *not* necessarily imply the importation of developed country standards). It promises to pose a simpler monitoring problem. Though what can be easily monitored (installation) is not what counts for continuing compliance (operation), there may be a substantial long run payoff to "practicing" the whole monitoring and enforcement game as part of institutional growth. Finally, concentrating on technology seems to reduce somewhat the opportunities for corruption, as compared to instruments that involve money transfers.[24]

22 *Caveat*: Largest, as already noted, need not imply best. But many with an interest in environmental protection will likely settle for largest.

23 *Caveat*: The trades involved in the adjustment may create hot spots—places at which ambient quality standards are violated, even if there were no violations in the pre-trading situation.

24 A similar rough sequencing to what follows could be sketched for fishery and forestry management, and, with modification to take account of special monitoring problems, for agriculture.

As public institutions grow in skill and reliability, and indeed as part of the process of fostering such growth, the specification of technology can evolve into the use of technological capability as the basis for writing permits that require particular discharge levels to be attained however they are achieved (technology-based standards). Such evolution could start in the metropolitan areas and be expanded to the hinterland as resources permit.

Finally, and again both leading and following growth in institutional capacity, these permits can gradually be made marketable among sources. Such an evolution might begin with a requirement that every proposed trade require a special request to the agency for authorization. At a later stage, approval might be assumed if no objection were made to a reported trade within some deadline. The agency might originally be responsible for doing (or overseeing) the modeling to check for hot spot creation. Later the sources could be required to have or buy the skills necessary to run the regional model(s).

Countries can, of course, enter this proposed sequence at the stage appropriate to their institutional capacity. This is not a rigid, all or nothing training program. At each stage undertaken the responsible agency(ies) should be challenged by the Prime Minister's Office and by international lending agencies to demonstrate that it (they) has (have) the current system under control and is (are) ready to move on to the next phase of effort.

Thus, in brief summary the position of this report is not that economic incentive instruments are bad or useless. It is that their use demands a high level of institutional capacity, especially if it is intended that the effort will be aimed at finding the least-cost (statically efficient) regional allocation of effort. Short of this target there is no second-best result to appeal to, and the institutional costs might, in effect, be paid in vain. Better to start with less demanding instruments, paying the price in other ways, such as some loss of innovation incentive, but looking at the process of environmental management in the long run and aiming at institutional evolution. This evolution could both be encouraged by the requirements of the instruments chosen and be aimed at the next level of sophistication.

Appendix

A Brief History of Technical Arguments Relative to the Choice of Environmental Policy Instruments

Taking up the idea that originated with Pigou, early advocates of the use of effluent or emission charges (e.g.: Kneese and Bower, 1968) assumed that the government knew the marginal damage function, that the function applied to every source, and that it was, in fact, a constant. Then it was easy to show that charging the marginal damage as the per unit cost of (tax on) discharging the damaging pollutant produced the socially optimal level of pollution at least cost. The marginal costs of all dischargers, assuming they respond rationally, would be equal to the common marginal damage. Most importantly, though, the authority need know *nothing* about the dischargers' costs.

Algebraically, assume we have N polluters, each with a function relating cost of pollution control effort to discharge, $C_i(D_i)$. Further assume that the regional damage function is linear and of the form:

$$DR = \alpha(D_1 + D_2 + \quad + D_N)$$

The first order conditions (F.O.C.s) for an optimum (where the sum of costs and damages is minimized) are $-C_i' = \alpha$ for every i.

A small variation on this first-best case begins to hint at some of the problems found in more realistic situations. Thus, assume the damage function is non-linear but still separable, so that each source can still be dealt with independently. It is then still possible to imagine the authorities announcing a charge schedule for each discharger such that the socially optimal pollution level is arrived at without either knowledge of discharge control costs or the use of trial and error. Thus, let the damage function be:

$$D_R = \alpha[D_1^2 + D_2^2 + \quad + D_N^2]$$

Then the F.O.C.s are of the form:

$$-C_i'(D_i) = 2\alpha D_i$$

Then at the optimum the charge level for each discharge would be different unless every cost function is the same.[25] But those levels still could be found by simply announcing a charge *schedule* that was the same for each discharger. No other knowledge would be necessary for the authority.

Notice, however, that if the damage function is not separable, this straightforward strategy will not work. If, for example, D_R were of the form $\alpha[D_1 + D_2 + \quad + D_N]^2$, marginal damages for the ith source are $2\alpha[\Sigma D_i]$ and no schedule of charges independent of the discharges of sources $j \neq i$ is possible. To obtain an optimal solution in one step requires knowledge by the agency of all the sources' cost functions for discharge reductions. However, because the discharge of every source is weighted the same in the damage function, the optimal charge—the one at which marginal damage equals marginal cost is the same for every source. Thus, even without being able to know or observe costs, the responsible agency could, in principle, arrive at the optimal charge by trial and error, so long as cost and damage function were conveniently shaped. That is, the agency could announce a charge, e_o, measure resulting discharges, and calculate the corresponding marginal damage, MD_o. If $MD_o > e_o$, the agency would increase the charge according to some rule, and vice versa.[26] Once the rule resulted in an overshoot,

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25 For example, if the cost functions were of the form $C_i = B_i(A_i - D_i)^2$, where B_i was a source-specific constant and A_i the raw or precontrol pollution load generated, then at the optimum $D_i = (B_i/B_i+\alpha)A_i$ and $C_i' = 2B_iA_i[1 - (B_i/B_i+\alpha)] = (2\alpha B_iA_i)/(B_i+\alpha)$. If $B_i \neq B_j$ and $A_i \neq A_j$ the optimal charge must be different for each source.

26 The rule would have to be tailored to the form of the marginal damage function and probably, to be even remotely practical, would reflect some guesses about the cost functions.

some stepping rule could be employed to encourage convergence. But remember that this is a theoretical possibility. Practical objections to trial and error are taken up below.

So far the discussion has focused on what to do when a damage function is available and marginal damages by source calculable. The recognition that we did not then have, and likely would not have in the foreseeable future, information on marginal or total damage functions,led economists to try to salvage the argument for charges and simultaneously bow to evolving U.S. policy by examining their use in encouraging the meeting of politically set (not necessarily economically optimal) ambient quality standards.

Baumol and Oates (1971) is the classic reference here. And their main result appears to retain the economy of centralized information needs that was part of the appeal of the earliest case. Thus, if ambient quality depends only on the sum of the regional discharges:

$$AEQ = f(D_1 + \quad + D_N),$$

where AEQ = ambient environmental quality. And is AEQ ≤ _, a standard, the first order conditions for cost minimization imply equal marginal cost at each source:

$$-C_i' = f' \text{ for all i}$$

analogous to the damage function case with equally weighted discharges.

Now trial and error again looks possible: Pick a charge. Observe AEQ. Raise the charge if the standard is violated; lower it if the AEQ is too good. Continue until the standard is just met. No knowledge of discharger cost functions is required; a result that rests on the equality of marginal costs required for the optimum in this situation. A simple and apparently elegant, but not, in fact, very helpful case. Again, leaving aside practical difficulties, the major problem is that this type of connection between discharges and ambient quality is a very special one—what is called in the trade a "mixing bowl," or a situation in which ambient quality can be taken to be uniform and affected the same by a unit of discharge from any of the sources. Location of the sources does not matter. As soon as that very special assumption is relaxed, the beauty of the argument on conserving information begins to be stressed.

Thus, when location matters but we are only interested in quality at one place, the problem becomes:

$$\underset{D_i}{\text{Min}} \; \Sigma_i C_i(D_i) - \lambda(f(B_iD_i, B_2D_2, \quad B_ND_N)-\_)$$

and the F.O.C.s are of the form:

$$C_i' = \lambda f' B_i$$

so that at the least-cost solution the sources' marginal costs in general differ according to their differential impacts (the B_i) on AEQ where it is being measured and compared to the standard.

Now it is true that if there really is only one point at which AEQ is of interest, the optimal charges bear a fixed ratio to each other. So trial and error is not out of the question in principle when the agency knows the B_i. If all the cost functions are conveniently shaped (do not exhibit falling marginal costs of additional removal anywhere) the feasible charge vector is also the optimal one.

But as soon as there is more than one point at which AEQ is of interest, the F.O.C.s take the following form (assuming for convenience strict equality of the constraints):

$$C_i' = \gamma_1 f_1' B_{i1} + \gamma_2 f_2' B_{i2} + \quad + \gamma_j f_j' B_{ij}.$$

Taking ratios does not get rid of the multipliers. And since these are just the shadow prices of the constraints it is intuitively clear that their failure to disappear implies a need for knowledge of control costs at the sources.[27]

The following discouraging results apply:

- From any starting charge vector there is

27 In reality these regional models are programming problems in which it is required that quality be at least as good as the standards at some finite set of points. This actually complicates even more the prospects for trial and error, since different points become binding constraints (and have non-zero shadowprices) at different vectors of discharges.

no straightforward rule for varying the charge vector elements that guarantees a move toward the optimum.

- Even if a feasible charge vector is found by luck, there is no reason to think it is optimal.

- There is no way to choose among a set of feasible charge sets, were these discovered, in the absence of observations on dischargers' costs.

These observations give rise to a useful if also discouraging rule: Obtaining static efficiency in the general case, with exogenously given ambient standards requires that the charge-setting agency have knowledge of all control cost functions as well as a complete characterization of the natural world systems that connect discharges and the points at which compliance with the ambient quality standards are met.[28]

Before going on, first, to relate these results to their duals in the world of discharge permits, and then to discuss matters concerning time, it is worth pausing to point out that even if trial and error were in theory a *possible* way to find an optimal charge set, it would not follow that this was a *good* idea, for trial and error when fixed capital is at stake can be very costly. This is not just because of the overbuilding penalty either. It will often be true that getting to removal level x by first building to remove x/2 and then adding another x/2 capability will be more expensive than going to x directly. And, to find the error is not the work of a short period, but would require long enough for every source to adjust and for measurements of AEQ to have been numerous enough to reduce standard errors to some acceptable level.

Marketable Permits: The Duals of Charges

In the context of a regional pollution-control model, emission charges and discharge standards are duals. Making permitted discharge amounts tradable among sources in effect takes advantage of this duality to bring into being one or more market prices, the real versions of the shadow prices that fall out of such models when standards are imposed. And it should not be surprising that results related to the efficiency and required information characteristics of marketable discharge permits can be understood as the duals of the results set out in the previous section.

Thus:

- The simplest sort of tradable permit scheme, in which discharge amounts are traded within a region but without restriction, will involve a single equilibrium price, the analog to a single charge level. This, in general, cannot be a statically efficient way of meeting a desired ambient quality standard, though it will produce the total amount of permitted discharge at the lowest aggregate cost.

- An ambient standard could be attained efficiently using an ambient quality (reduction) trading system. In this, sources would have to hold portfolios of rights to reduce quality (increase pollution) at some finite number of monitoring points in the ambient environment. Each point would constitute a separate market with, in general, a separate price. Those prices, in turn, would translate into different implied prices for changes in discharges via translation through some agreed on natural-world-model that predicted ambient pollution levels from discharges by sources.

Thus, obtaining static efficiency in meeting desired ambient standards involves more complex trading and decisions on the part of sources—the analogue to the information and computation intensity implied for the agency by the need to find individually tailored charges.

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28 Actually the problems of comparison on which even the simple static efficiency results are based are worse than generally admitted to. This is because our programming approaches produce quality no worse than the standard at every modeled point. In general, however, the pattern of just-binding and non-binding constraints will be different for different patterns of discharges. Thus we are not really fulfilling the conditions for judging outcomes or the basis of cost only, that is the "outputs" of the alternatives are not, in fact, equal. If we knew the benefit function we would be able to demonstrate which pattern was optimal by the test of minimizing costs plus damages. (See Smith and Russell, 1990 for a discussion of this point.)

One new problem comes up in the static marketable permit case: hot spots. That is, unless the initially allowed total of permitted discharge is small enough, there will always be possible trades that could concentrate discharges in such a way as to result in violation of the ambient standard somewhere. Strategies proposed to guard against this eventuality have the effect of either (or both) complicating the trading schemes or reducing the efficiency of the permit market by fragmenting it. Thus:

- If there is only one monitoring point of interest, trades can be required to take place at "trading ratios" defined by the relative impact of each party to the trade on that point. Thus, an amount of discharge being sold by (moved from) a source with a small effect on the monitoring point to one with a large effect would be reduced by the ratio of those effects. This would have the effect of producing individualized prices and would be analogous to the situation described under charges for a single monitoring point.

- If there are many monitoring points it will not in general be clear, in the absence of real time intervention by the agency running a regional model, what the correct "trading ratio" should be for any particular trade.

- Sub-regionalization of discharge permit trading markets (restricting the possible set of trading partners by some distance-based decision rule) will make each market less likely to function in the desired competitive way and will mean that the regional total of discharges is not even attained at lowest cost in equilibrium. Though if all desirable trades are assumed to be made, as they are in modeling exercises, zoned systems can reduce the cost of meeting a standard by allowing the agency to segregate sources that most and least heavily affect quality at the monitoring points (Tietenberg, 1995).

The matter of transaction costs has been examined formally by Stavins (1995), and his conclusions —that taking them into account reduces the attractiveness of permits schemes; and, in particular, that there exists a danger of over selling such systems when the details have been ignored— reinforce the points being made here and, even more obviously, in the sections below on matching institutional capability with choice of policy instruments.

Second Best: What Can Be Said?

It seemed to some of the early enthusiasts for emission charges that even if they granted the objections and caveats so far outlined it would still be more desirable (more nearly efficient) to have in place an emission charging scheme of some kind than to use another instrument such as non-tradable permits, unless these were chosen to be the duals of the efficient charges. But it can be shown that no such general notion of "second bestness" holds. For example, a comparison of a uniform charge and a non-tradable discharge permit (standard) defined by applying a uniform rollback percentage to unregulated discharge levels reveals that which of these instruments produces the lower regional resource cost of meeting an ambient standard depends on the details—on the shapes of the sources' cost functions and how they are located relative to the monitoring point (Russell, 1986).[29]

The Dynamic Setting

One might well read the above sections to say that enthusiasm for the static efficiency properties of economic incentive instruments of environmental management lacks a basis in *a priori* argument. This seems to be true both in the first and second best senses. At this point another line of argument suggests itself: the virtues of these instruments in a dynamic

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29 The rollback factor, in a setting of multiple ambient monitoring points, would be based on the size of the reduction in ambient concentration required at the worst such point in order to meet the desired ambient standard. Thus, if $AEQ_i - \_ > AEQ_j - \_$ for all j, then this difference is used to define the regional rollback percentage, R.

$R = (AEQ_i - \_) / (AEQ_i)$

and for every source, k, the permitted discharge $D_{kp} = (1-R)D_{ko}$, where D_{ko} is the unregulated level of discharge at k.

setting.

The most easily demonstrated of such possible virtues concerns the incentive to innovate in environment saving ways: Comparing for one source the alternatives of a charge and a nontradable permit that are themselves dual (the charge would produce a discharge response at the same level as the permit) the charge gives more incentive to the source to try to shift its marginal cost curve down. And, if the charge were the instrument of choice, the level of discharge after the shift would be lower than the original standard.

If you are an environmentalist, this effect has much to recommend it. But if you are an economist you unfortunately must acknowledge that this larger incentive is not necessarily *better* in the sense of producing a dynamic path that is overall more efficient. Indeed, it is unfortunate but true that we economists cannot really address the question of dynamic efficiency of instruments in even as satisfactory a way as we do the static analysis.[30] This is not to say that the required maximization (or minimization) problem cannot be written down in general functional notation. It *is* to say that we cannot characterize the key response functions in such a general problem statement in a credible way (as credible, for example, as the characterization of marginal pollutant removal costs as increasing, perhaps without limit, as removal approaches 100 percent). Further, it cannot be expected or claimed that a statically efficient policy is the best (or even necessarily a desirable) initial policy for a dynamic problem. That is why non-myopic optimization techniques such as optimal control and dynamic programming have been developed.

There is, however, another side to the dynamic setting, that is, the simpler, but practically important matter of adjustment to exogenous change, forgetting dynamic efficiency. In this matter it *is* possible to say something useful:

- As exogenous growth (or shrinkage) and change occur in a regional economy the agency must, in general, act by adjusting the values of policy instruments. Thus charges or non-marketable permit terms would have to be adjusted just to maintain feasibility (meeting an ambient standard) let alone optimality.

- Such adjustment, if it is intended to maintain optimality, will be as information and computation intensive as the original setting of charges or permit levels. Even if the only goal is to keep meeting the ambient standard there will be political chips and actual resources expended in the process. (It may be necessary to adjust the law itself. But even changing the implementing regulations will provoke political battles and quite likely litigation.[31]

- Marketable permits systems, while subject to the hot spot problem as already noted, are otherwise self-adjusting in the face of exogenous change. This may be their greatest single advantage over both charges and non-marketable permits.

A Word on Enforcement

No policy instrument that requires an economic actor (firm, farm, lower government jurisdiction) to act against its narrow self-interest will have its intended effect unless effort is put into enforcing it.[32] Now, enforcement means

30 The environmental management problem becomes dynamic in the sense that time enters explicitly and centrally, not just as the period that separates us from the future, when there is reason, such as exogenous growth, to expect the charge or standard facing each source to change over time; while adjusting removal capacity and, as important, seeking new removal technology, requires time and resources; and where the costs of removal capacity adjustment are a function of already installed capacity.

31 It is worth noting that the prospect of such battles--over the inability of EPA to allow for growth in U.S. regions that were not attaining required ambient air quality--is generally credited as the spur to the establishment of the "off-set" system, one of the three parts of what is almost a tradable permit system for air quality management (Liroff, 1980).

32 Admittedly, some of the actors may comply voluntarily out of a sense of moral commitment or a fear of eventual negative publicity. But the observed rates of noncompliance even in the presence of some enforcement effort (Russell, 1990) in the U.S. strongly suggest that social responsibility is not the equilibrium state for the population at large.

different things for different instruments: seeing that a discharge permit is complied with, or seeing that the proper amount of emission charge is being paid, for example. But whenever the instrument is aimed at controlling discharges, enforcement will have to involve some effort to measure (monitor) discharges. If self-monitoring by sources is required, as it now is across most major sources of air and water pollution in the U.S., the agency will have to put some effort into auditing the self-reported results.[33] Violations of standards or misreporting of discharges for purposes of charge billing will have to be punished.

It is sometimes claimed that emission charges are "self-enforcing." It is not clear what this really means, but it does *not* mean that after an agency puts in place a charge system it can just sit back and collect the money while all the sources move to equate their marginal costs to the charge. In the absence of monitoring one could expect many (most, all, depending on one's pessimism about the human condition) to under-report discharges. If zero enforcement effort were certain, actual discharges might be at the unregulated level and charge payments very small.

It must also be noted that marketable permits complicate the monitoring problem by adding the requirement for real-time updating of agency records for trades so that each source is evaluated relative to the proper requirement. But that aside, the monitoring and enforcement problem is not really different from that for charges or for non-marketable permits.

Conclusion

There is, it seems, much less to the static case for economic instruments than might be concluded from the hangover in standard textbooks of the conventional wisdom of the 1970s. Even the dynamic case is limited to the claim of a larger incentive to innovate in pollution reduction technology under a charge than a standard. Neither is there any encouraging second best result that would support the use, for example, of a uniform charge as preferable to an arbitrarily assigned set of discharge standards. And, finally, there is no advantage in enforcement to going with an economic incentive.

In these circumstances one can see as the good news the fact that very little is given up if entirely different approaches to environmental management are chosen in order to conserve scarce agency resources and to adjust to modest institutional capabilities.

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33 Auditing of self-reporting is complicated by the ephemeral nature of the act of polluting. That is, it is very difficult, indeed one might well say practically impossible, to determine what source "i" discharged yesterday unless a measurement device was in place then. So an "audit" cannot have the same meaning as an IRS audit of the paper trail that defines one's income. Continuous monitoring devices do help here, but there still must be a way to check upon them.

Glossary of Technical Terms

Ambient Environment: The natural world in its many manifestations (air, water, vegetation, wildlife) that humans are in contact with when outside enclosed spaces.

> **Ambient Environmental Quality**: Quantitative characterization of how pleasant, healthy, ecologically robust the ambient environment is.
>
> **Ambient Environmental Quality Permit**: A regulatory instrument that would convey the right to degrade the ambient environment by a certain amount at a certain point. For example, a power plant emitting pollutants to the air that, after dispersion and transport through the air, degrade the environment at points where ambient air quality is measured, would have to own permits, one for each such point of monitoring, equal to the amount of degradation it is calculated to cause. These calculations would be done using some authorized or official mathematical model of the regional atmospheric system.

Benefits (of an environmental program): The reductions in damages attributable to the programs (i.e., damages in the absence of the program less damages with it in place.) Here the term benefits will always be taken to mean in money terms.

> **Benefit-cost Analysis**: Comparing the money values of benefits and costs of a program, policy or regulation without regard to the identity of the recipients.

Command and Control: A phrase that may mean many things when examined in detail. Broadly, however, it is used by many analysts of environmental policy to refer to policy instruments that involve telling polluters (or exploiters of natural resources) what they are to achieve. Contrasted with economic incentive (or "market-based" incentives) in which what is to be achieved is decided by the source or exploiter in response to an administered price (see emission charge) or an administered market (see marketable permits).

Discharge: Refers here to the waste material or energy that leaves the premises of a manufacturer, farmer, or even household, and enters the ambient environment. May be:

> **Point-source Discharge**: When it occurs via a smoke stack, pipe or channel; or,
>
> **Nonpoint-source Discharge**: When it occurs along a line (as from a moving auto), as a sheet (as runoff from a forest, farm, or construction site); or when many very small point sources (household cooking fires) are grouped for analytical convenience.
>
> **Discharge Standard**: An authorized (legal, acceptable to the regulatory agency) amount of pollution discharge per unit time.
>
> **Discharge permit**: An official document embodying the terms of a standard.

Economic Incentive (Market Based Incentive): Broad terms referring to regulatory tools that reward desired behavior or penalize undesired behavior without specifying exactly what level of behavior the parties subject to the incentive should maintain. Major examples include:

> **Deposit-refund Systems**: At purchase a deposit is part of the price. This may be for a container (as for beverage cans and bottles) or for material (as for solvent) or for the entire product (as for an auto or auto battery). When the object of the deposit is returned to a specified location a payment is made to the returner (the "refund"). This may be seen as a self-financed subsidy for "good" behavior.

Emission (or Effluent) Charge: A charge per unit of discharge of one or more specific pollutants.

Marketable Permits: These may be discharge permits or permits to take fish or to cut trees in some specific place. They are transferable among would-be users and can be presumed to trade at prices determined by the relevant costs of the users (e.g.: the costs of reducing pollution discharge by one unit).

Subsidy: A reward for desired behavior. These may be awarded at the margin (as in bottle refunds) or as reductions in the overall cost of pursuing some strategy (as in tax credits for installation of pollution control equipment, or intergovernmental grants to cover costs of building sewers or waste water treatment plants).

Hydraulic Load: The volume of water that must pass through a treatment plant, for example, per unit time.

Pigou/Pigouvian Charge: Pigou was an English economist usually credited with Marshall with creating the foundations of microeconomic analysis. His name is often attached to the idea of a charge levied on environmental insults such as pollution discharges and equal to the marginal social damage (in money terms) caused by the insult at the socially efficient point (see static efficiency).

Second Best: A term referring to the notion that when it is impossible to achieve a result of least cost or maximum net benefit (economic efficiency) it may be possible to say that one or another strategy will get the economy closer to the efficient result than any other. The "general theorem of the second best" shows that in the setting of an economy in which more than one reason for inequality between marginal cost and marginal willingness to pay exists (as would happen in a very simple world in which a polluter was also a monopolist), correcting fewer than all the causes of inequality does not necessarily improve the situation over the status quo before the attempt. The phrase is often used as an adjective and often the implication is that a "second best" solution to a public regulatory decision *can* be found. The general theorem result gives reason to be skeptical.

Static: Timeless. A static result in economics assumes, in effect, that nothing has changed for long enough to allow adjustment within the allowed range of flexibility (e.g.: short run with fixed capital or long run with investment allowed) and that nothing is anticipated to change over the foreseeable future. Each period is like the last and the next.

Static Efficiency: Broadly, a situation in which the economy is on its utility frontier—in which no redistribution of factor effort or of output could make any person better off without making someone else worse off. More narrowly, in environmental analysis this refers either to situations in which marginal damages (as from pollution), equal marginal costs of avoiding damage (so that the sum of costs and damages is minimized); or the costs of meeting some politically chosen ambient quality standard are at a minimum. Both in a static setting.

Sustainability: (Sustainable development) Maintaining the services and quality of natural resources over time as development proceeds.

- Using renewable resources at rates less than or equal to their regeneration rates.
- Using non-renewables as efficiently as possible given the existing technology at any time, recognizing that changing technology can substitute for resources.

Technology Specification: An environmental regulatory tool that involves specifying what technology regulatory parties should employ (as in wastewater treatment methods, or fishing gear, or best management practices in farming).

Technology-based Standards: An environmental regulatory tool in which the *result* of using a particular technology in the context of a particular regulated party is estimated by a study (not by actual

application). This result becomes a requirement, as a discharge standard, for example. The technology applied is usually chosen by a process that begins with legislative definitions such as "best available technology".

Transfer Coefficients: Mathematical models of the diluting, transforming, and transporting functions of the natural world can sometimes be linearized for application to static situations. The results of linearization may be coefficients that can be multiplied by discharges to produce estimates of resulting ambient quality degradation.

Transfer Payments: Payments from one party to another in the economy that are not matched by resource transfers in the other direction. When a pollution source pays an emission charge to the government on its actual discharges this is a transfer payment. (Economists often put the word "mere" in front of transfer to indicate that nothing central to resource allocation is going on.)

References

Anderson, Dennis, 1990. "Environmental Policy and the Public Revenue in Developing Countries," Environment Working Paper No. 36, Environment Department, The World Bank (July).

Andrew, Dale, 1995. "The Trade/Environment Nexus: Considerations for IDB Policy and Practice," Strategic Planning Division, Strategic Planning and Operational Policy Department, Inter-American Development Bank (April).

Arora, Seema, and Timothy N. Cason, 1995. "An Experiment in Voluntary Environmental Regulation: Participation in EPA's 33/50 Program," *Journal of Environmental Economics and Management*. Vol. 28, No. 3 (May).

Baker and McKenzie. *Latin America Legal Developments Bulletin*. Various issues.

Baumol, William J., and Wallace E. Oates, 1971. "The Use of Standards and Prices for Protection of the Environment," in *Swedish Journal of Economics*. Vol. 73, No. 1.

Bernstein, Janis D., 1993. *Alternative Approaches to Pollution Control and Waste Management: Regulatory and Economic Instruments*. Washington, D.C.: The World Bank.

Birch, Melissa and C. A. Primo Braga, 1993. "Regulation in Latin America: Prospects for the 1990s," *The Quarterly Review of Economics and Finance*. 33, special issue, 119-33.

Boeker, Paul H., 1993. "Latin America's Economic Opening and the Rediscovery of Foreign Investment," in *Latin America's Turnaround: Privatization, Foreign Investment, and Growth*. Paul H. Boeker (ed.), San Francisco: ICS Press, pp. 3-12.

Bohm, Peter, 1995. "Environmental Taxes, Carbon Taxes, Tax Recycling and Tax Distortions," Working paper from the Department of Economics, University of Stockholm, revised from a paper presented at the International Institute of Public Finance, 50th Congress, Cambridge, MA, August, 1994.

Bohm, Peter, and Clifford S. Russell, 1985. "Comparative Analysis of Alternative Policy Instruments," in A.V. Kneese and J.L. Sweeney (eds.) *Handbook of Natural Resource and Energy Economics*. New York: North-Holland.

Brañes, Raul, 1991. *Institutional and Legal Aspects of the Environment in Latin America, Including the Participation of Non-Governmental Organizations in Environmental Management*. Washington, D.C.: Inter-American Development Bank.

Bruce, Neil, and Gregory M. Ellis, 1993. "Environmental Taxes and Policies for Developing Countries," Working Paper, Policy Research/Public Economics, Policy Research Department, The World Bank (September).

Business Council on Sustainable Development in Latin America, 1995. *Environmental Policies in Latin America*. Policy Series #1 (January) Monterrey, Mexico.

Cammack, Paul, 1992. "States and Markets in Latin America" in *The Market and the State: Studies in Interdependence*. Michael Moran and Maurice Wright (eds.), New York: St. Martin's Press.

Cropper, Maureen L. and Wallace E. Oates, 1992. "Environmental Economics: A Survey," *Journal of Economic Literature*. XXX, (June), 675-740.

Cutter Information Corporation. *Environmental Watch: Latin America*. Various issues.

Dessus, Sebastien, David Roland-Holst, and Dominique van der Mensbrugghe, 1994. "Input-based Pollution Estimates for Environmental Assessment in Development Countries," Technical paper No. 101, Paris, OECD.

Dewees, Donald, 1992. "Tort Law and the Deterrence of Environmental Pollution," in T. Tietenberg (ed.), *Innovation in Environmental Policy*. Aldershot, Hants, England: Edward Elgar.

Dourojeanni, Marc, 1994. "Survey of Bank Staff on the Environmental Performance of the Member Countries of the IDB," Inter-American Development Bank internal memorandum, Washington, D.C., 3/07.

Ebisemiju, Fola, S., 1993. "Environmental Impact Assessment: Making It Work in Developing Countries," *Journal of Environmental Management*. Vol. 38, 247-273.

The Economist, 1995. "Colombia's Other Gangsters," March 25, p. 48.

Eskeland, Gunnar S., and Emmanuel Jimenez, 1992. "Policy Instruments for Pollution Control in Developing Countries," *The World Bank Research Observer*. 7:2, July, 145-169.

De Janvry, Alain and Elisabeth Sadoulet, 1993. "Market, State, and Civil Organizations in Latin America Beyond the Debt Crisis: The Context for Rural Development," *World Development*. 21(4), 659-74.

Farrow, Scott, 1995. "The Dual Political Economy of Taxes and Tradable Permits," *Economic Letters*. Vol. 49, 217-220.

Forster, Nancy R., 1992. "Protecting Fragile Lands: New Reasons to Tackle Old Problems," *World Development*. 20(4), 571-85.

Fuhr, Harald, 1993. "Mobilizing Local Resources in Latin America: Decentralization, Institutional Reforms, and Small-scale Enterprises," in *Small Firms and Development in Latin America: The Role of the Institutional Environment, Human Resources, and Industrial Relations*. Brigitte Späth (ed.), Geneva: International Institute for Labour Studies, pp. 49-66.

Gandhi, Ved P., and Ronald T. McMorran, 1995. "How Macroeconomic Policies Affect the Environment:

What Do We Know?" Unpublished paper, Washington, D.C.: The International Monetary Fund, Fiscal Affairs Department (April).

Garrett, James L., 1995. "Food, Nutrition, Agriculture, and Environment in Latin America: A Review,
1970-1995."

Gerchunoff, Pablo and Germán Coloma, 1993. "Privatization in Argentina" in *Privatization in Latin
America*. Manuel Sánchez and Rossana Corona (eds.), Baltimore: The Johns Hopkins University Press, pp. 251-300.

Gerchunoff, Pablo and Juan Carlos Torre, 1992. "What Role for the State in Latin America," in *Towards
A New Development Strategy for Latin America: Pathways from Hirschman's Thought*. Washington, D.C.: Inter-American Development Bank, The Johns Hopkins University Press, pp. 259-80.

Gligo, Nicolo, 1980. "The Environmental Dimension in Agricultural Development in Latin America,"
Cepal Review. 12, 129-43.

Gottret, Pablo, Garrett Andrés, Cecilia Castillo, Earl McLaren, 1995. "Jamaica: IDB: Environmental Strategy Proposal," Report prepared for the Inter-American Development Bank, La Paz, Bolivia: Nogales, Gottret, Martins and Associates (May).

Hachette, Dominique, Rolf Lüders, and Guillermo Tagle, 1993. "Five Cases of Privatization in Chile" in
Privatization in Latin America. Manuel Sánchez and Rossana Corona (eds.), Baltimore: The Johns Hopkins University Press, pp. 41-100.

Halter, Faith, 1991. "Toward More Effective Environmental Regulation in Developing Countries," in
Denizhan Eröcal (ed.), *Environmental Management in Development Countries*. Paris: OECD.

Hansen, Jorgen K., 1995. "Policy Instruments for Pollution Control in Developing Countries," Consulting
Report to the Interamerican Development Bank, Washington, D.C., (March).

Hojman, David E., 1993. *Chile: The Political Economy of Development and Democracy in the 1990s*.
Pittsburgh, University of Pittsburgh Press.

Hueth, Darrell L., 1995. "The Use of Subsidies to Achieve Efficient Resource Allocation in Upland Watersheds," Washington, D.C.: Inter-American Development Bank, Environmental Protection Division, Working Paper ENV-1 (March).

Inter-American Development Bank, 1992. "Guatemala: Nonreimbursable technical cooperation funding
for the institutional strengthening of the National Commission on the Environment and the establishment of an environmental program," memo Washington, D.C. (Nov. 17).

Inter-American Development Bank, 1993a. Bahamas Investment Sector Loan, BH-0011, Environmental
Summary, Washington, D.C. (Sept.)

Inter-American Development Bank, 1993b. "Agenda Memorandum: Colombia: Proposal for Loans for
An Environmental Program," Washington, D.C., September.

Inter-American Development Bank, 1993c. "Agenda Memorandum: El Salvador. Non-reimbursable
Technical-Cooperation Funding in Support of El Salvador's Environmental Program, Washington, D.C., September.

Israel, Arturo, 1987. *Institutional Development: Incentives to Performance*. Baltimore: Johns Hopkins
University Press for the World Bank.

Jenkins, Glenn, and Ranjit Lamech, 1994. *Green Taxes and Incentive Policies: An International Perspective*. San Francisco: Institute for Contemporary Studies.

Kneese, Allen V., and Blair T. Bower, 1968. *Managing Water Quality: Economics, Technology, Institutions*. Baltimore: Johns Hopkins University Press for Resources for the Future.

Liroff, Richard A., 1980. *Air Pollution Offsets: Trading, Selling, and Banking*. Washington, D.C.: Conservation Foundation.

Lyon, Randolph M., 1989. "Transferable Discharge Permit Systems and Environmental Management in
Developing Countries," *World Development*. 17:8, 1299-1312.

Margulis, Sergio, undated. "The Experiences of Brazil, Mexico, Chile and Argentina in the Use of Economic Instruments in Environmental Policy," The World Bank.

Martin, Juan M. F., 1988. "Interaction Between the Public and Private Sectors and the Overall Efficiency
of the Economy," *Cepal Review*. 36, 101-16.

Martinez, J.C., H. Souza, J.W. Wright, and W.J. Vaughan, 1993. "Bahamas Investment Sector Loan, BH-
0011, Environmental Summary," Inter-American Development Bank, September.

Naipaul, V.S., 1995. *A Way in the World*. New York: Vintage Books.

Niklitschek, Mario, 1995. "Conceptual Consideration on Subsidies for Forest Plantations," in *Workshop*
on the Use of Financial Incentives for Industrial Forest Plantations: Proceedings. Washington, Inter-American Development Bank, July.

Ocampo, José Antonio, 1991. "The Transition from Primary Exports to Industrial Development in Colombia," in *Diverging Paths: Comparing A Century of Scandinavian and Latin American Economic Development*. Magnus Blomström and Patricio Meller. Washington, D.C.: Inter-American Development Bank, The Johns Hopkins University Press, pp. 213-44.

Ortega, Emiliano, 1992. "Evolution of the Rural Dimension in Latin America and the Caribbean," *Cepal*
Review. 47, 115-36.

Panayotou, Theodore, 1994. *Economic Instruments for Environmental Management and Sustainable*

Development. Final Report, prepared for the United Nations Environmental Programme's Consultative Expert Group Meeting on the Use and Application of Economic Policy Instruments for Environmental Management and Sustainable Development, Nairobi; Cambridge, Harvard Institute for International Development (December).

Portes, Alejandro and Richard Schauffler, 1993. "Competing Perspectives on the Latin American Informal Sector," *Population and Development Review*. 19(1), 33-60.

Quiroga, Ricardo, Jorge Fernandez-Cornejo, and Utpal Vasavada, 1995. "The Economic Consequences of Reduced Fertilizer Use: A Virtual Pricing Approach," *Applied Economics*. Vol. 27, 211-217.

Russell, Clifford S., 1973. *Residuals Management in Industry: A Case Study of Petroleum Refining*. Baltimore: Johns Hopkins University Press for Resources for the Future.

Russell, Clifford S., 1986. "A Note on the Efficiency Ranking of Two Second-Best Policy Instruments for Pollution Control," *Journal of Environmental Economics and Management*. Vol. 13, No. 1 (March).

Russell, Clifford S., 1988. "Economic Incentives in the Management of Hazardous Wastes," *Columbia Journal of Environmental Law*. May.

Russell, Clifford S., 1990. "Monitoring and Enforcement," in P. Portney (ed.), *Environmental Regulation in the U.S.: Public Policies and Their Consequences*. Washington, D.C.: Resources for the Future.

Russell, Clifford S. and Philip Toy Powell, 1994. "Report to the Office of Technology Assessment on the Efficiency and Fairness of Candidate Approaches to Environmental Pollution Management," unpublished, Vanderbilt Institute for Public Policy Studies, Nashville, August.

Russell, Clifford S., and William J. Vaughan, 1976. *Steel Production: Processes, Products, and Residuals*. Baltimore: Johns Hopkins University Press for Resources for the Future.

Russell, Clifford S., Robin Bidwell, and Hilary Sunman, 1990. "Emission Charges in Practice," a paper presented at the 1990 meeting of the European Association of Environmental and Resource Economists. Venice, March.

Sánchez, Manuel, Rossana Corona, Otoniel Ochoa, Luis Fernando Herrera, Arturo Olvera, and Ernesto Sepúlveda, 1993. "The Privatization Process in Mexico: Five Case Studies" in *Privatization in Latin America*. Manuel Sánchez and Rossana Corona (eds.), Baltimore: The Johns Hopkins University Press, pp. 101-200.

Smith, V.K., and Clifford S. Russell, 1990. "Demands for Data and Analysis Induced by Environmental Policy," in Berndt and Triplett (eds.), *Fifty Years of Economic Measurement: The Jubilee of the Conference on Research in Income and Wealth*. Chicago: University of Chicago Press.

Southgate, Douglas, 1995. "Subsidized Tree Plantations in Ecuador: Some Issues," in *Workshop on*

the
Use of Financial Incentives for Industrial Forest Plantations: Proceedings, Washington, D.C.: Inter-American Development Bank, July.

Stavins, Robert N., 1995. "Transaction Costs and Tradeable Permits," *Journal of Environmental Economics and Management*. Vol. 29, No. 2, 133-148.

Syrquin, Moshe, 1991. "A Comparative Analysis of Structural Transformation in Latin America," in *Long-*
Term Trends in Latin American Economic Development. Miguel Urrutia (ed.), Washington, D.C.: Inter-American Development Bank, The Johns Hopkins University Press, pp. 81-116.

Thomson, Ian, 1992. "Urban Bus Deregulation in Chile," *Journal of Transport Economics and Policy*.
26(3), 319-24.

Thorbecke, Erik, 1993. "Impact of State and Civil Institutions on the Operation of Rural Market and Nonmarket Configurations," *World Development*. 21:4, 591-605.

Tietenberg, Tom, 1995. "Tradable Permits for Pollution Control When Emission Location Matters: What
Have We Learned?" in *Environmental and Resource Economics*. Vol. 5, No. 2, 95-113.

Tietenberg, Tom, 1996. "Private Enforcement of Environmental Regulations in Latin America and the
Caribbean: An Effective Instrument for Environmental Management?," ENV Working Paper, Washington, D.C.: Inter-American Development Bank. (forthcoming)

Tlaiye, Laura and Dan Biller, 1994. *Successful Environmental Institutions: Lessons from Colombia and*
Curitiba, Brazil. LATEN Dissemination Note #12. The World Bank, Latin America Technical Department, Environment Unit, December.

United Nations Economic and Social Council, 1995. "Financial Resources and Mechanisms for Sustainable
Development: Overview of Current Issues and Development," Report of the Secretary-General, Paper Prepared for Commission on Sustainable Development Working Group on Finance (April).

Urrutia, Miguel (ed.), 1991. "Conclusions," in *Long-Term Trends in Latin American Economic Development*. Washington, D.C.: Inter-American Development Bank, The Johns Hopkins University Press, pp. 157-64.

Vaughan, William J., and Sergio Ardila, 1993. "Economic Analysis of the Environmental Aspects of Investment Projects," Working Paper ENP100, Washington, D.C.: Inter-American Development Bank, December.

Wall Street Journal, 1995a. "Utilities Overcomply with Clean Air Act, Are Stockpiling Pollution Allowances," Nov. 15, A-6.

Wall Street Journal, 1995b. "Computer Sales Sizzle as Developing Nations Try to Shrink PC Gap," June
29, p. 1-A.

Wall Street Journal, 1995c. "Conduct Codes Garner Goodwill for Retailers, But Violations Go On,"

July
3, p. 1-A.

Wall Street Journal, 1995d. "Populist Disaster, Venezuela is Suffering: Its Economy Strangled by Too
Many Controls," August 16, A-1.

Wall Street Journal, 1995e. "Money Transfer: Bolivia is Selling Off State Firms to Fund Its Citizens'
Future," August 15, A-1.

Werneck, Rodério L. F., 1991. "The Uneasy Steps Toward Privatization in Brazil" in *Privatization of*
Public Enterprises in Latin America. William Glade (ed.), San Francisco: ICS Press, pp. 59-74.

World Bank, 1995. "National Environmental Strategies and Action Plans: Key Elements and Best
Practice," Environment Department, Work in Progress (February).