WHY POLICY MAKERS DON'T USE ENVIRONMENTAL TAXES

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Economists have long expressed a nearly universal preference for using taxes and other economic incentive systems to remedy the market's failure to correctly price or otherwise appropriately manage environmental resources. Environmental taxation in particular has an especially persuasive economic foundation: imposing a "corrective" tax on polluters equal to the value of the damages they cause the environment will encourage them -- without any other regulatory persuasion -- to undertake precisely the emission controls and other environmental protection measures that an omniscient regulatory authority would dictate.

The key advantage of corrective taxation is its economic efficiency, especially relative to conventional command and control regulation. Taxes and other market-based approaches encourage often numerous pollution sources to bring to bear their detailed knowledge of emission control costs in the pursuit of environmental improvement at the lowest social cost. The traditional command and control approach, in contrast, relies on only the small fraction of that information typically available to real-world regulators, so that specific limitations the environmental authority can dictate to pollution sources generally will be more costly than absolutely necessary to achieve a given environmental improvement goal. This information advantage of economic incentive approaches is what people mean when they say that these instruments "harness market forces" in service of environmental improvement.

None of this has been lost on policy makers, who regularly call for adopting innovative market-based solutions, especially pollution taxes, to solve the nation's pollution problems, They hope to achieve ever more stringent environmental goals at politically acceptable costs using these more finely-honed tools. But in recent years a more cogent explanation for the popularity of environmental taxation is the promise that this approach can not only provide environmental protection, but at the same produce revenue for cash-starved governments. Other taxes are widely thought to do harm to the economy in the process of generating revenue because they decrease the incentives to work, save, and invest. Environmental taxes, in contrast, appear to

offer a tantalizing "win-win" prospect for fiscal policy makers -- they can improve environmental quality and raise revenue in the process.

The ability of corrective taxation to protect the environment and to raise revenue at the same time is indeed remarkable. But perhaps more remarkable is that these sorts of taxes have rarely, if ever, been used by policy makers. Environmental regulation largely consists of traditional emission standards and other command and control restrictions and dictates, supplemented only very recently by attempts to use a few economic incentive approaches, such as marketable permits for SO_2 emissions reduction and beverage container deposit-refund systems. How can it be that corrective taxes -- touted by economists as superior to existing methods of environmental regulation, and offering governments valuable revenues seemingly for free -- has not been adopted as the regulatory approach of choice in practice?

It is tempting to attribute this either to a colossal oversight on the parts of environmental regulators, or to a lack of statutory authority to use taxes as environmental regulatory instruments. But U.S. environmental statutes are actually far from hostile to using taxes as regulations, and to the degree that they are not receptive to this approach, ample time has passed during which more precise regulatory authority to use environmental taxes could have been clarified. Furthermore, no environmental policy maker could be unaware of the strong arguments in favor of using taxes over other approaches for environmental protection given the number of studies of how, when, and why economic incentives could or should be used.

So the explanation for the fact that corrective taxes have seldom, if ever, been used in environmental regulation must lie elsewhere. The task of this paper is to diagnose the real reasons why practical policy making in the environmental arena has not embraced corrective taxes as both the premier cure for pollution woes and a source of badly-needed government revenues. As such, the point of departure of this paper is different from that of most other studies of the role of economic incentive approaches in environmental policy, because the question here is not why environmental taxes <u>should</u> be used, but instead why they <u>are</u> <u>not</u> commonly employed as regulatory instruments in practice.

Some of the issues discussed here are touched on in the economics literature, particularly the careful and practical summary of the state of environment economics by Cropper and Oates[1] and the classic comprehensive text by Baumol and Oates[2]. This paper's primary contribution is that it attacks the question from a fresh perspective and with a slightly different emphasis than other studies. The central theme of this paper is that the lack of real-world use of taxes in environmental regulation can only be explained by examining the political economy of environmental policy, a broader perspective that the purely economic efficiency-based point of view.

Three key elements of the practical environmental policy-making landscape are identified here as the major impediments to using corrective taxes as environmental regulatory instruments. One is a host of unrealistic expectations policy makers often have regarding the operation and effects of corrective taxes. Regulators frequently assume that relative to other regulatory approaches, environmental taxes always are easier to implement, are less expensive from a social perspective and still provide tax revenues to the government, and will be preferred universally by all parties affected. When these hopes for the approach are not met in practice, environmental taxes are often dismissed as good tools in theory and texts, but not in the messy world of policy practice.

Another major impediment to using corrective taxes stems from often profound conflicts between the numerous different goals that guide practical environmental policy, and the weighing of costs and benefits objective that underlies corrective taxation. When the policy goal of net benefits maximization, as embodied in the corrective tax approach, conflicts with other objectives, such as mitigating undesirable impacts on subsets of the population and avoiding irreversible environmental damages, policy makers frequently use other regulatory instruments whose operation and results are less at war with their multiple social goals.

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[1] M.L. Cropper and W.E. Oates, "Environmental Economics: A Survey", Journal of Economic Literature, Vol. XXX, June 1992, pp. 675-740.

[2] W.J. Baumol and W.E. Oates, The Theory of Environmental Policy (Cambridge, U.K.: Cambridge University Press, 1988).

One final reason for the reluctance to use taxes as environmental regulatory tools flows from the equity consequences of this approach compared to other ways to secure environmental improvement. The corrective tax method of environmental regulation imposes a financial burden on top of the cost of any pollution controls it induces, because residual emissions are taxed. Of course, taxing pollution is the means by which polluters are encouraged to adopt emission controls, so some might wonder why this is a problem. It can be because other methods of achieving largely the same degree of environmental improvement do not generate this extra tax burden on polluters. Policy makers thus require a strong justification for this distributional result in order to prefer taxes over other regulatory approaches, but often lack a sufficiently powerful case in practice.

Collectively, these considerations suggest that making any progress toward more using environmental taxes in practice will be far harder than if the impediments were simply lack of information or ambiguous regulatory authority. Time and experience can remedy some of the past difficulties policy makers have encountered when attempting to use corrective taxes as environmental regulatory tools, especially unrealistic expectations. But the more profound problems of conflicts between overall environmental policy objectives and the specific net-benefits maximization goal embodied in corrective taxes, and the distributional impacts of taxes relative other regulatory approaches, are unlikely to be resolved wholesale in favor of environmental taxes. Thus, the conclusions reached in this paper indicate that it is possible to use taxation in environmental regulation, but not nearly as frequently or as easily as the purely economic point of view seems to suggest.

The main body of this paper explores these themes in greater detail. It is organized into four sections as follows:

- Section 1 reviews the basics of corrective taxation as applied to environmental problems. The focus here is not only on the instrument's characteristics and

operation, but more fundamentally on the way that economists have traditionally justified its use.

- Section 2 explores why corrective taxation has seldom, if ever, been used in environmental policy. Various reasons are examined ranging from unrealistic expectations about the use and effects of incentive systems as regulatory instruments, to conflicts between the goals underlying environmental taxation and the mandates governing regulatory policy.
- Section 3 examines a variation on environmental taxation prevalent in the literature, the "standards and charges" approach under which environmental taxes are used to achieve predetermined policy goals. The section explores a slightly different set of reasons for the failure to use even this more limited version of environmental taxation in practice.
- Section 4 concludes the paper with some tentative observations about, and suggestions for, using environmental taxes in the future more successfully.

1. Environmental Taxation in Theory

The operation of environmental taxes is usually illustrated using simple and somewhat stylized examples such as the following. Suppose a number of sources discharge a pollutant into the air of a particular region. In the absence of any regulatory or other legal mechanisms that restrict their emissions, the polluters will face a zero price for using the air for purposes of waste disposal and will act accordingly.[3] In this situation, possibly substantial harms might occur, such as human health impacts and damages to agricultural and other resources.

[3] For purposes of this discussion, when faced with a zero cost of polluting, sources are assumed not to engage in any emission controls other than those dictated by other economic reasons. For example, recapturing some chemical pollutants can be more profitable than allowing them to escape if they can be recycled and reused cost effectively. Hence, this analysis does not assume that no controls on emissions will exist without regulatory intervention, only that whatever controls do exist are undertaken for reasons unrelated to the external environmental damages caused by the pollution.

According to the economic view, the policy maker's problem is to decide what level of pollution control stringency is socially optimal by weighing the costs of reducing emissions against the environmental benefits pollution abatement provides. In doing so, the relationship between emissions levels and environmental damages is clearly relevant. The usual assumption is that for each unit decrease in the amount of emissions, environmental damages fall by smaller and smaller amounts. This implies that starting from no emissions at all, the initial amounts of pollution cause very low damages. But the same amounts of emissions added to an already positive pollution load cause higher environmental damages, so that the pollution damages to society become increasingly costly as more emissions occur.

The other pertinent piece of information involves the emission control costs incurred by the pollution sources. Here, the normal assumption is that marginal control costs are initially low for most sources, but rise to greater and greater levels, perhaps at different rates depending on the source, as the overall stringency of pollution control increases. That is, it is less costly to abate the first 10 to 15 percent of emissions than it is to control the last 5 or 10 percent.

The environmental policy maker's task is thus to determine the socially optimal level of pollution by balancing emission control costs against the benefits of lower environmental damages. In most cases, the outcome will be something less stringent than disallowing any emissions whatsoever, but certainly tighter than no controls at all. In fact, the intuitive policy decision rule is to continue to reduce emissions as long as the marginal benefits of less pollution outweigh the costs of the necessary controls.

Using Corrective Taxes to Achieve the Optimum

While the conceptual basis for determining the optimal level of pollution is easily understood, it is less clear exactly how to achieve this result through specific actions to be taken on the parts of the sources of emissions. One method might be for the environmental authority to dictate to each source the level of emissions it can generate. This traditional command and control approach essentially requires the regulatory authority to parcel out the optimal level of emissions, source-by-source, providing each polluter with an

allowable amount. But is there are differences in control costs across polluters, the regulatory authority may need a great deal of information about those costs to allocate the total emissions such that aggregate control costs are at or near the minimum level necessary to reach the target level of pollution abatement.

Corrective taxation, however, offers a radically different alternative for translating the optimal level of total emissions into specific guidance for individual sources. This method approaches the problem using the paradigm of demand and supply. In the case of a good traded in the marketplace, the optimal level of production and consumption is found where the good's marginal cost of supply equals its marginal benefit to its consumers. In such markets, the competitive behavior of profit-maximizing producers and the utility-maximizing decisions by budget-constrained consumers achieve the optimal level of production and consumption of a good.

In the case of sources that pollute the air, changes in environmental damages as total emissions vary can be thought of as forming the basis of a "demand" for environmental improvement. Similarly, the increase of emission control costs as allowable pollution levels fall suggests a "supply" of environmental improvement (or, equivalently, a supply of emissions control). But here, there is no market interaction between the suppliers of emissions reduction and the demanders of clean air by which to establish this optimal amount of emissions. Nevertheless, if the environmental authority can intervene and provide the correct "price" for polluting, market interactions should cause the optimal level of emissions to result without having to dictate specific targets to polluters on a source-by-source basis.

Indeed, just as the equilibrium market price for a good calls forth just the right amount of supply, setting the tax on emissions at the level of environmental damages marginal emission cause will encourage just the right amount of control by all sources collectively to reach the optimal pollution target. This must be so because sources will prefer to control their emissions as long as the cost of doing so is less than the tax rate, and will prefer to pay the tax when incremental emission control costs exceed the tax. Setting the tax rate equal to marginal environmental damages at the optimal level of pollution therefore causes sources to engage

in abatement up to the point at which marginal control costs equal marginal environmental damages, precisely the condition that defines the efficient result from a social perspective.

In addition to achieving the optimal overall level of emissions, the corrective tax approach also attains this goal at a lower social cost than command and control-style regulations that are insensitive to differences in control costs across sources. To see this, suppose that only two sources emit equal amounts of air pollutants in the relevant geographical region. Suppose further that to reach the overall optimal emissions level of half the unregulated amount, both sources are subject to command and control regulation requiring each to reduce emissions by 50%. If the two sources face different costs of controlling emissions, this regulation will be inefficient, because the constrained total level of emissions could be achieved at a lower cost by shifting allowable emissions to the high control-cost source from the lower cost source.

This is effectively what the tax approach accomplishes. As long as the incremental control costs of the two polluters are unequal, there are further cost efficiencies to be gained by continuing to shift emissions from the low-cost controller to the high-cost one. Only when the two sources' marginal abatement costs are the same will the efficient levels of emissions for each be achieved. But because the corrective tax confronts each polluter with the same price for emissions, each will control to the point at which their incremental control costs equal the tax rate, thereby ensuring as well that their marginal costs of controlling emissions will indeed be equal.

It is significant that corrective taxes accomplish all of this privately and in a decentralized way as the regulated firms respond to the newly-created price signal. Once the price of polluting is set correctly, the polluters' self-interested decision making will cause not only the optimal level of emissions and damages to materialize, but also ensure that these goals are achieved at minimum cost to society. This what economists mean by "harnessing market forces" in the pursuit of environmental improvement.

The conventional illustration of the superiority of corrective taxation thus demonstrates that the essence of the approach is elegant and disarmingly easy to understand. But, as will be seen later, it is very

important to distinguish between the simplicity of the analytical core of corrective taxation and the simplicity of the illustration itself. Indeed, a number of assumptions are necessary to describe the operation and advantages of corrective taxation using the analysis presented so far. In particular, the situation described above is one in which environmental damages depend only on the total level of pollution, so that emissions from different sources cause the same damages regardless of their location. Because of this, it is possible to speak in terms of emissions instead of environmental damages themselves, and in turn, to specify the tax rate in terms of emissions rather than the value of the harms caused. Perhaps more important, this also implies that only one tax rate is needed regardless of the number and characteristics of the individual emission sources. As will be seen, when this assumption fails, matters become considerably more complex for environmental taxation, as they do for all regulatory approaches.

Corrective taxation also requires valuing environmental harms, setting the tax rates based on marginal social damages at the optimal level of pollution, levying taxes directly on the activities that cause the harms, and incorporating into the tax rates all policy goals significant to regulators. The tasks of targeting the required tax appropriately, obtaining agreement on the value of environmental harms, and reflecting all of the myriad real-world policy goals in monetary tax rates, should not be taken lightly in practice. Nevertheless, these and other simplifying assumptions are quite appropriate for demonstrating the power and effectiveness of using corrective taxation to address environmental problems.

Corrective Taxation Requires More than an Efficiency-Based Justification

The appeal of corrective environmental taxes thus runs quite deep in terms of economic efficiency, and resonates strongly with the basic faith economists place in free-market outcomes. After all, a well-functioning market requires no special attention or oversight to achieve optimal outcomes. Intervening with a corrective environmental tax thus seems a reasonable intrusion to obtain possibly large gains in economic

efficiency, especially relative to traditional command and control regulations, historically the policy instrument of choice among regulators.[4]

Seen in this light, the corrective tax remedy is really no more than an exercise in supplying the "missing prices" of environmental harms caused by pollution when the market fails to generate these signals on its own. Hence, over the years economists have championed the corrective tax approach for addressing environmental problems largely based on efficiency-enhancement grounds, for a persuasive case can be made for taxing pollution based on the harm done instead of engaging in cumbersome and costly command and control regulation, much less doing nothing about pollution at all.[5]

But viewed from a public policy perspective, using environmental taxation requires more than an efficiency-based justification. In particular, relative to other regulatory approaches, environmental taxes entail distributional or "equity" outcomes that must be justified. Under command and control regulation, for example, sources incur costs to reduce their emissions to the level specified by the standards, but any

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[4] It is worth noting in passing that, in some sense, actively intervening in the market to set the appropriate price for pollution is viewed by economists as a last resort. When the market fails to price or manage something correctly, most economists would first suggest that the property rights involved be better defined. Under this more passive approach, whoever ends up with the clarified "title" to the resource being harmed would have an incentive to defend its value using the standard legal mechanisms, such as tort, property, and contract law. This property-right clarification approach will not work for many environmental problems, however, primarily because large numbers of entities are often involved. Many people might be harmed slightly by the degradation of air quality due to emissions from many different sources. Even if the "right" to clean air was clearly allocated to the affected population, it is difficult to imagine each person pursuing each of the emission sources that cause him or her harm. Thus, many market failures that give rise to environmental externalities require more interventionist remedies, such as corrective taxes.

[5] The popularity of corrective taxes also stems from several other more subtle features. One is that taxes ensure that the long run profitability, and hence entry, conditions facing polluters are optimal. Approaches that do not charge polluters for residual emissions and damages will tend to encourage excessive entry. That is, if firms can use the environment for disposal without paying for that right, too many firms will attempt to use this common property resource, reducing the efficiency of the outcome. Another benefit of the tax approach over command-and-control relates to the incentive to develop new emission control technologies. Under command-and-control standards, this incentive is generally confined to seeking lower-cost innovations that meet the requirements of the regulation, because polluters gain nothing by reducing emissions below the current standards. Under taxes, however, the incentive is not only to develop less expensive pollution control methods, but also to explore technologies that achieve even greater emission control than presently, because firms save taxes by lowering their emissions.

remaining emissions are allowed without charge. Under corrective taxes, however, sources incur not only costs to control their emissions, but also owe taxes on their residual emissions. Of course, all approaches remove from polluters the right to unlimited free use of the environment for disposal purposes, so polluters will be worse off than under no regulation. But corrective taxes further alter the distribution of rights in the economy relative to other approaches by charging sources for residual pollution even though the costs of avoiding these emissions are greater than the benefits of doing so.

Public policy makers may well decide that stripping polluters of the right to use the environment for free disposal of any emissions at all is a reasonable action, especially if the mechanism that generates this outcome -- corrective taxation -- also improves the efficiency of environmental regulation. But this is a policy choice that almost always must be buttressed by considerations other than economic efficiency, a point often obscured in purely efficiency-based evaluations of alternative regulatory instruments. In theory, other regulatory instruments can achieve similar environmental improvement, perhaps not quite as efficiently, but impose only the costs of pollution controls, thereby preserving polluters' right to free disposal of any remaining emissions.

Indeed, in some circumstances marketable permits can provide the same environmental improvement just as efficiently as corrective taxes. For example, when a number of sources of emissions contribute to a particular pollution problem, the efficient solution can be obtained either by promulgating a tax equal to the marginal environmental damages at the optimal level of pollution, or by distributing emission permits equal to the optimal amount of pollution and allowing source to trade them. In both cases, taxes and marketable permits both achieve the optimal result in every short- and long-run sense of the term. Thus, if the permits are distributed free to emission sources ("grandfathered" as this is sometimes called), setting aside implementation and transactions cost issues, the choice between the two approaches rests solely on distributional concerns, because corrective taxation charges sources for residual pollution and the marketable permits approach does not.

Of course, it remains true that while corrective taxes are not always superior on efficiency grounds to other approaches, they certainly can be in many instances. Nevertheless, the point is not whether environmental taxes are theoretically more efficient, but whether the potential efficiency enhancement they provide over other approaches is sufficient to justify the distributional outcomes they entail. That is, in practice taxes must be chosen not over no regulation, but instead over other regulatory options, so the environmental improvement and gains in efficiency provided by taxes must be measured relative to the outcomes those other instruments provide. The closer the efficiency performance of alternative regulatory approaches to that of corrective taxation, the smaller will be the incremental efficiency enhancement of using taxes to justify the equity outcomes they also produce. It is easy to imagine cases in which the efficiency improvement taxes provide over another alternative is quite modest, but the added tax burden on emission sources is very substantial. As a result, successfully advocating corrective environmental taxes over other approaches generally will require more than efficiency-based arguments.

One strategy for addressing this distributional issue is to side-step the matter by arguing that it is not the intent of the corrective tax to collect revenue on the residual pollution; it is merely a side effect of the policy's operation. Hence, in keeping with the more traditional economics of public finance, one might try to "lump sum" the tax revenues back to the polluters to mitigate the purely distributional impact of the tax. Doing so will still reap the efficiency benefits of correctly pricing the environment, but will reduce the financial burden. But no one seriously believes that any revenues from an environmental tax will somehow be returned to the polluters.[6] The equity implications of using corrective taxation instead of other types of environmental regulations cannot be dodged so easily.

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[6] It is conceivable that revenues from an environmental tax might be returned to industry if the funds were dedicated to pollution control expenditures. A few such programs exist in several European nations, but these are not true corrective taxes, because the rates are not set with reference to the values of the environmental harms caused. Moreover, returning the funds on the condition that they be spent on pollution control suggests that the programs are really non-regulatory methods of achieving environmental improvement combined with, in a sense, a pooled financing mechanism. A good survey of these charge systems and other programs is contained in Economic Incentives for Environmental Protection, Organization for Economic Cooperation and Development, 1989.

Fortunately for advocates of environmental taxation, sentiment in recent years has been that polluters have no right to the free use of the environment in the first place. According to this view, polluters should not only pay for emission abatement measures, but also for any residual environmental damages they continue to cause. This "polluter pays" principle is the fundamental argument typically used to justify the equity implications of corrective environmental taxation: It is reasonable to require polluters to pay for even the residual damages they cause the environment if they have no right to pollute for free anyway. This resolution of the equity issue essentially denies that the tax payments are a loss suffered by polluters relative to other regulatory approaches; instead it views them as eminently reasonable liabilities polluters should face for damaging environmental property owned by others.

Economists are thus reasonably comfortable with the polluter-pays principle as the equity justification to support using environmental corrective taxation over other regulatory approaches. If public policy makers have decided that polluters should pay for the harm they cause, setting a corrective tax equal to marginal environmental damages is the regulatory enactment of that principle.[7] From an equity perspective, environmental taxes are simply the equivalent of presenting polluters with a bill for the damages they do to the environment that they are not entitled to cause in the first place. As long as there is a close connection between the tax rate and the environmental damages pollution causes, corrective taxation thus seems to be a nearly perfect embodiment of the underlying polluter-pays philosophy.

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[7] It is possible for a firm's total tax payments to be greater than the actual environmental damages caused by its pollution. This could happen if the marginal social cost of damages rises as the firm's emissions increase. If the contributions of individual sources to the pollution is "small" relative to the total, however, the marginal social damages will not change over the range of any particular firm's emissions, so that each firm's tax bill will equal the actual damages it causes. Of course, in the aggregate the total tax collected from the entire industry might exceed total damages. Nevertheless, as with any input supplied to an industry less-than-perfectly-elastically, the difference between the total tax payments of the industry and the total amount of environmental damages is a "rent" that accrues to the environmental resource's owner. See Baumol and Oates (1988), supra note 2, pp. 52-54, and the references cited there, for a complete treatment of this issue.

2. Why Environmental Taxation Is Not Used in Practice

Despite all of their widely acknowledged advantages, corrective taxation has rarely, if ever, been used in environmental regulation. This section seeks to diagnose why attempts to use corrective taxes have been unsuccessful. Although there probably are others, five major reasons are summarized here. These are: (1) a host of expectations policy makers often have concerning the operation of market-based approaches that are invariably unmet in practice; (2) unfair comparisons of incentive systems' performance with that of other regulatory approaches; (3) incompatibility of the revenue generation objective for taxes and environmental policy goals; (4) conflicts between multiple environmental policy objectives and the central goal of corrective taxation; and (5) difficulties frequently encountered in providing the necessary equity justification for using corrective taxes. The first two apply to using all economic incentive systems, not just corrective taxation, in place of traditional command and control approaches. The remaining three, however, are specific to using environmental taxes instead of both command and control and, in some very important cases, other incentive systems.

Unrealistic Expectations

One reason for the infrequent use of economic incentive systems -- all market-based approaches, not just corrective taxation -- is that many policy makers believe that these approaches will be universally preferred to, and simpler to use than, other regulatory methods. These expectations stem largely from having inundated policy makers over the years with persuasive, but highly simplified demonstrations of the advantages of economic incentive approaches. A classic example contrasts an inefficient command and control regulation (one that is insensitive to control cost differences among multiple sources of pollution) with a marketable permits system under which the aggregate pollution level is the same, but firms trade emission rights, thereby achieving the regulatory target at a lower social cost. The permits are initially granted to individual polluters in amounts equal to the emissions each would be allowed under the command and control regulation. Any trading of permits after the initial distribution would be in the interests of both the

sellers and the buyers. Hence, this example shows that substituting marketable permits for command and control can reduce total control costs without making anyone worse off. Perhaps more significantly, from the regulator's perspective it is far easier to use marketable permits to obtain this efficiency enhancement than to try to refine the command and control regulation to account for unequal control costs across sources. The marketable permits system instead encourages emission sources to account for unequal control costs by trading permits, thus utilizing information not known by the environmental authority.

Although this is a useful way to illustrate the powerful results of market-based approaches, repeated exposure to this example leads many people to believe that economic incentive systems will always be socially less costly than other approaches, that they will be preferred by all of the affected parties, including the polluters, and that they will be easy to implement. None of these expectations is warranted in practice.

Theoretically, incentive systems will be less costly from a social perspective than traditional command and control approaches as long as the policy goal to be achieved is the same. They also will be better -- in the sense that their net social benefits will be greater than under other approaches -- if the explicit goal is to achieve the economically optimal outcome, that is, where marginal social costs and benefits are equated. But much of environmental regulatory policy is not formulated the way textbook comparisons of alternative interventions would appear to suggest. Regulators often have in mind a somewhat vague goal of risk management for a particular environmental problem and then fashion a variety of regulatory and non-regulatory mechanisms to address it, alternatives that typically result in different degrees of risk reduction.

In light of this, an economic incentive system need not impose lower social costs than a command and control approach if their levels of pollution control are different. For example, a "weak" command and control option could well impose lower social costs than a more stringent corrective tax aiming at the optimal outcome. The costs of the corrective tax might indeed be the minimum amount required to achieve the efficient result, but these could well exceed the costs of a command and control option that targets a less-strict level of pollution control.

In practice, because more than purely economic considerations enter into policy making, it is not uncommon for traditional command and control regulation to target a less stringent degree of environmental improvement than could be justified simply on the basis of costs and benefits. Comparing the resulting lenient command and control regulation with a corrective tax option that seeks the optimal (and more stringent) level of environmental improvement will show the latter to be more costly than the former. It is thus unrealistic to expect that any incentive system always will be socially less costly than command and control regulation.

The expectation that everyone will prefer incentive systems over command and control approaches is obviously misguided, but seems to be an unwarranted generalization of the results of substituting marketable permits for command and control regulations. When using marketable permits in place of traditional command and control, assuming that the initial free allocation of permits to emission sources is identical to their allowable emissions under the command and control option, any trades of these allowances would be voluntary, and thus could not make anyone worse off.

While this is particularly helpful in selling the advantages of incentive systems to regulators, the problem is that this conclusion does not apply to corrective taxes, or really to most economic incentive systems other than marketable permits. Corrective taxes may well achieve environmental goals at lower total cost than command and control approaches, but the tax bill for the remaining emissions still must be paid. Hence, the regulated industry could easily prefer command and control to environmental taxes.

Another unrealistic expectation concerning the use of economic incentives is that they will be easier to design, administer, and enforce than other forms of regulation. This belief is fostered by the sense that "all you have to do is set the tax rate, or decide on the total level of emissions and distribute the permits, and the market will handle everything else." While using market-based regulatory strategies can provide some administrative and other benefits, their use still requires regulators to make often difficult policy choices and to grapple with complex causal relationships between economic activities and pollution damages. In

designing a marketable permits system, for example, one must decide the total permissible level of environmental damages and exactly what activities will require permits. Similarly, when using corrective taxes, deciding what exactly will be taxed and at what rates are still necessary policy-making steps.

In general, tracing from environmental harms to economic activities to decide where to impose a regulation, setting the boundaries of a regulation's scope, and deciding its stringency can be just as hard when using market-based approaches as in formulating traditional command and control policies. Economic incentives can help to improve the efficiency of regulatory outcomes, but they do not obviate the need to make policy choices, and they will not magically simplify real-world environmental problems. These approaches do not erase the challenges of real-world risk management; they only add options for addressing them.

Indeed, in some cases, especially those that require frequent and accurate monitoring of emissions, using an incentive system or any approach that requires detailed information on emissions, can be even more cumbersome and difficult than traditional technology-based command and control. When emissions from many sources at a facility are expensive to monitor, it may be far easier to specify controls based on technologies with known pollution control properties.

Finally, attempts to use economic incentives in practice often founder on the reality that regulators must give something up in exchange for the efficiency-enhancing benefits of these approaches. In particular, regulators must cede some control over the exact outcome of market-based approaches to polluters. Under marketable permits systems, for example, cost-minimizing trading among the polluters determines the ultimate distribution of emissions. Consequently, while the total quantity of emissions is fixed, the regulator does not know with any certainty exactly how much pollution will be generated by particular facilities. This problem is even more pronounced for corrective taxation, because regulators must completely relinquish control over the total amount and the location of emissions to the polluters.

Thus, for regulators to be confident in using incentive systems, they must find it acceptable for market forces, supplemented by altered incentives, to determine precise outcomes. But this is not necessarily an easy shift of policy making stance for regulators, given both their experience with the tight control offered by command and control regulation and the underlying mandates of the nation's various environmental statutes. Regulators are charged with protecting the environment, so using corrective taxes and accepting whatever results emerge -- despite being efficient from an economic perspective -- seems to run counter to their fundamental responsibilities.

Some of this sentiment underlies a familiar criticism of corrective taxes: that they make damaging the environment simply another cost item for polluters, rather something that is, in some sense, fundamentally wrong. This is perhaps why successful attempts to use incentives in environmental regulation in recent years have focused on marketable permit systems as opposed to taxes. Because the marketable permits approach offers certainty concerning at least the overall outcome, policy makers tend to be more receptive to allowing the market to determine the details.

Unfair Comparisons of Policies

Another major reason why economic incentive systems are not widely used is that policy makers often implicitly use different criteria for comparing the outcomes under market-based policies to those of alternative approaches. In part, this also stems from the fact that real-world environmental problems are far more complex than the simple circumstances depicted in the usual demonstrations of the superiority of market-based approaches. For example, the environmental damages attributable to emissions of a particular substance might depend on the amount and concentration of emissions, on the medium into which the emissions occur, on the nature and value of the activities potentially injured by the emissions, and even the location of the emission source. Similarly, many pollution problems are caused by non-point sources, such as agricultural runoff, which can be very difficult to measure and regulate. Pollution problems that fit the description of textbook examples are the exception, not the rule.

Hence, in many real-world applications, policy makers quickly realize that applying incentive systems such as corrective taxes and marketable permits to achieve the optimal result requires a large amount of data collection and analysis. Actual pollution problems present many complications concerning design, measurement, implementation, and enforcement issues, all of which can expand the dimensions of the optimal corrective tax or efficient marketable permit problem.

The result is that the apparently simple-to-use and powerful-in-effect advantages of economic incentive systems, so often demonstrated to policy makers, succumb to a "death by a thousand cuts" when applied to real-world problems. Regulators discover that to use environmental taxes or marketable permits accurately requires so much study and analysis that they are discarded as being mostly the province of theoretical economics, not the day-to-day business of environmental management.

The economic literature on economic incentive approaches unfortunately has served to reinforce this view by focusing nearly exclusively on what is required to achieve the economically optimal result. Designing marketable permits systems, for example, becomes a very data-intensive exercise when the damages of a particular source's emissions depend on its location and concentration, and the distribution and characteristics of environmental resources harmed by pollution. Complex trading ratios for emissions from different sources are then necessary to account for these heterogeneous harms. For example, if one source's marginal emissions cause twice as much damage as another's, for the first source to increase its emissions by one unit, it would have to purchase permits amounting to two units of emissions from the other source.[8] Using corrective taxes in such situations will similarly require a large matrix of tax rates. Under either approach, deciding exactly what is taxed or permitted -- emissions or damages -- and how to translate between the two, remains an information- and computation-intensive task.

[8] One could also achieve the same result (with the same degree of complexity) by using ambient pollution permits under which, instead of permitting emissions that are then traded in various ratios, permits relate to the right to impair environmental quality at particular locations.

An even more troubling finding for corrective taxation, however, is that the tax rates should be set at the level of marginal social damages at the optimal level of pollution, not the marginal social damages that occur in the initially unregulated state of the world. That is, the damage caused by a unit of emissions from a particular source might be, say, $1 prior to any regulation, but at the optimal level of emissions, marginal damages from this specific source might be $.50 per unit. Hence, the regulator must compute the efficient set of tax rates based on the damages caused by each source at the optimal levels of emissions. But doing so requires information not only on how environmental damages vary as emissions change, but also the abatement costs of all of the different sources.

This finding erases what regulators initially consider to be the great advantage of using corrective environmental taxes: that all one must do is estimate damages and then promulgate taxes based on them. In reality, using taxes to achieve the optimal result requires a complete computation of the optimal emission and pollution outcome in order to define the correct set of tax rates, a task most practitioners view as hopelessly complex. In theory, with all of that information, regulators could promulgate highly cost-sensitive command and control regulations and be done with the matter. Corrective taxation was supposed to avoid the need to gather all of this abatement cost information.

The major unintended consequence of the literature's attempts to analyze marketable permits and corrective taxes in more realistic circumstances thus has been to convince everyone that using them correctly and accurately is extremely difficult. As a result, practical applications have been confined to marketable permit systems for a handful of very simple cases. For example, permit systems have been, or will be, used to implement the phaseout of CFCs and the nationwide limitation on SO_2 emissions from power generation and other sources. In these situations, the reality (or the assumption) is that the damages attributable to emissions from any particular source are the same, so that complex trading ratios between sources are not necessary. This homogeneity makes using tradeable permits far more tractable. Moreover, in these few instances,

marketable permits are used to achieve regulatory targets dictated by what really is a political process, so the larger issue of overall economic optimality of the policy targets has been avoided.

Most economists would argue that the literature's emphasis on what it takes to achieve optimality is not intended to preclude the compromises between feasibility and efficiency that are inherent in addressing complex actual environmental problems. Indeed, they would agree that it is not practical to aim for developing a truly optimal set of tax rates when this might require numerous different rates to address the spectrum of actual marginal damages that different emission sources cause, rates that might also have to be routinely updated to reflect changing market and environmental conditions. Instead, one might devise a smaller set of tax rates and then sort the emission sources into a few broad classes. Of course, this will not achieve the most efficient outcome, but such a compromise could be an improvement over the relevant alternatives.

Although it is easy to imagine developing applications of economic incentive systems for complex real-world pollution problems, there is considerable reluctance to do so. This is somewhat peculiar given the track record of environmental policy making using command and control regulations. This apparent double standard appears to flow from a subtle difference in the intellectual points of departure for command and control regulations, on the one hand, and economic incentive systems, on the other. When regulators evaluate command and control approaches, their goal is environmental improvement. They recognize that their interventions inevitably will be imperfect, but whatever ultimately is done will at least be some improvement over the status quo.

But when regulators consider economic incentive systems, especially marketable permits and taxes, the major advantage of these systems -- improved economic efficiency over command and control -- is foremost in their minds. When it becomes apparent that any feasible use of incentive systems in practice will also be imperfect and thus inefficient, these approaches seem less appealing. For traditional forms of regulatory intervention, imperfection is part of the messy business of addressing real-world environmental

problems. For economic incentive systems, however, their much-touted advantage in improving the efficiency of outcomes is somewhat at war with their less than perfect performance in practice.

Unfair as they may be, these inappropriate comparisons of incentive-based and other regulatory policies do occur. To some degree the literature has helped to perpetuate this problem because of its focus on the difficulties of achieving optimal outcomes in complex circumstances. Policy makers are offered little practical guidance on how to construct imperfect, but workable, forms of incentive systems and then compare them to other, also imperfect, regulatory approaches. Thus, the literature's emphasis on the goal of optimality is at cross-purposes with the fact that all regulatory approaches in reality will be less than perfect. In practice, the best is the enemy of the good.

Incompatibility of Revenue Generation and Environmental Policy Goals

The reasons discussed so far for the infrequent use of corrective taxation in environmental policy making apply to all incentive systems. Other difficulties, however, arise in the process of deciding to use environmental taxes specifically. One such problem occurs when policy makers seek to use corrective taxes to raise government revenue as a byproduct. The possibility that one can collect revenue and accomplish environmental improvement at the same time is indeed a tantalizing prospect. But there are profound differences between taxes intended to raise revenue and taxes used as environmental regulatory instruments.

Good revenue-raising excise taxes from both the economic and political perspectives are those that are small enough on a per-entity basis not to cause large distortions in economic behavior, but are also spread over many payers, so that they raise large amounts of revenue. Thus, one normally tries to tax a large-volume economic good or activity that is inelastically demanded and supplied. In addition, to make these taxes easy to administer, one also focuses on goods or activities that are traded or otherwise well documented by the private sector. A good revenue-raising tax collects large amounts of revenue, does not pose a substantial burden on individual entities, and is easy to implement.

But the criteria that define good environmental taxes are quite different from those that characterize efficient revenue-raising taxes. True corrective taxes are environmental regulations, not revenue-generation policies, hence, they are supposed to be "noticed" by polluters because the whole point is to internalize the environmental harms. Moreover, corrective environmental taxes often must target activities that are not traded in, or well-documented by, the private sector. For example, discharges of toxic wastes to air, land, and water are disposal activities involving products with negative, not positive, economic value, so levying taxes on these emissions is a very different administrative task than taxing, say, gasoline or some other traded commodity.

Perhaps more important, however, is that the tax revenues produced in total and on a per-entity basis, as well as elasticities of demand and supply, are largely irrelevant for true environmental taxes because the purpose is to correct the incentives of polluters, not to raise revenue for the government. Revenues generated by environmental taxes are a byproduct of their operation, not their objective. In fact, from an environmental policy perspective, the best outcome under a true corrective tax is to collect no revenue at all. In this case, the cost of reducing pollution to zero turns out to be lower than the social cost of the environmental damages, so completely eliminating the emissions altogether and collecting no tax revenue is the optimal result.

Because the circumstances that define good revenue-raising excise-tax opportunities are completely different from those that call for using a corrective tax as a regulatory intervention, it is not easy to find corrective environmental taxes that also manage to produce significant revenues and are easy to implement on top of existing market transactions. This is certainly the lesson learned in the various attempts in recent years to levy so-called environmental taxes to raise revenue for the federal government. These proposals tend to fail in practice for quite understandable reasons. To be sold as environmental taxes, they must at least implicitly satisfy some common-sense requirements for any environmental regulation, such as providing risk-reduction benefits to society. But because these proposals do not begin with an environmental problem to be solved, the

policy justification for these taxes as regulatory instruments amounts to a search for "good things" that might happen as a result. Of course, clever analysts can always find some positive results in any intervention.

The problem is that when any environmental benefits are uncovered in these searches, it turns out that the "environmental taxes" as proposed are not particularly efficient regulatory instruments those benefits. This occurs because whatever is located in the process of searching for desirable environmental results is not the original motivation for promulgating the tax. Hence, other regulatory instruments could be focused more closely on the underlying environmental problem and thus would be more effective at obtaining the environmental benefits in question. Furthermore, as these tax proposals are studied further, the reality that they do not provide "money for free" sets in; identifiable entities must pay the tax liabilities and normally they are not happy about it. Thus, revenue-raising excise taxes masquerading as environmental taxes usually fail to be used because they encounter significant difficulties in satisfying the basic requirements of environmental regulations: targeting a real pollution problem, being relatively efficient at addressing the problem, and possessing a convincing equity rationale.

Of course, it is conceivable that a corrective environmental tax could yield large revenues. But proposing such a tax as an environmental regulation would first begin with the pollution problems to be solved and, after careful study and deliberation, the tax would be found to be a reasonably sound environmental regulatory intervention. Tracing from an environmental tax developed in this way to its environmental benefits would be direct and coherent, and would not reveal other, far superior regulatory policies for addressing those environmental concerns.

Somewhat ironically, it is probably accurate to say that the desire to use environmental taxes making to raise government revenue has likely done more to discourage than to encourage their use. In the end, however, the inability to justify environmental taxes when the real goal is to raise government revenues should be viewed not as a failure for true corrective taxation, but as the natural result of attempting to promulgate an environmental policy without a compelling regulatory rationale.

Conflicts Between Environmental Policy Objectives and Corrective Taxation Goals

Another reason why corrective taxes are not used is that the fundamental policy goals of environmental regulation and true corrective taxation sometimes conflict. Hence, even overcoming the hurdles outlined so far, environmental taxes still will not be used when the basic goals of the regulator are at variance with the policy evaluation objective that lies at the heart of corrective taxation.

True environmental taxation calls for taxing pollution at a rate equal to the marginal social damages caused. The beauty of this approach is that it achieves the optimal level of pollution at the least cost, and it does so by encouraging private-sector market participants to use their detailed knowledge in service of balancing social costs and benefits of pollution control. The problem is that the beauty of this approach is in the eyes of the beholder. Economists find the operation of corrective taxation particularly attractive, not only because of its optimality properties, but also because they are generally in agreement with other policy objectives that are satisfied by taxes. One is the polluter-pays principle, which most economists find a reasonably sound equity justification for the distributional results of environmental taxes relative to other regulatory instruments that do not charge polluters for residual emissions and their associated harms.

Economists also are attracted to the proposition that policy makers should strive to maximize net social benefits in developing environmental regulations, another policy criterion satisfied by corrective taxation. But here there is often some controversy. Although improving the cost-effectiveness of environmental regulations and requiring polluters to pay for the environmental harms they cause are both themes that resonate with many non-economists, there is far less agreement that a purely economic assessment of the net social benefits of environmental regulations should be the primary guide to successful environmental stewardship.

Indeed, it is often observed that many of the nation's environmental statutes do not call for weighing the costs and benefits when setting goals for pollution control and environmental risk management. Instead they direct regulators to reduce pollution risks to reasonable or acceptable levels, to set such goals as

minimizing the risks of harm to human health, or to apply available pollution control technologies, regardless of the risks avoided. For example, regulations for hazardous waste management seek to achieve extremely low levels of risk often at great cost. Hence, the guiding principles embodied in environmental statutes and their legal interpretation are often at variance with the underlying premise of corrective taxation that public policy should balance costs and benefits to arrive at economically optimal regulations.

At first glance, making decisions on any basis other than marginal costs and benefits might seem irrational. Upon reflection, however, setting more stringent targets for pollution control than economic analysis would dictate based on conventionally measured costs and benefits could be simply a crude, but pragmatic way of accommodating a host of other social goals and considerations. For example, society's concern about pollution may extend beyond the expected value of pollution-related harms, to the distribution of those impacts among different segments of the population. Similarly, many environmental regulatory programs affect the welfare of generations yet to be born. It is reasonable to adopt a more conservative stance on issues that affect one's distant descendants, especially when environmental effects are somewhat uncertain and possibly irreversible.

For a variety of reasons, therefore, the complete set of relevant environmental policy objectives can conflict with the more narrow goal of maximizing net economic benefits. In some cases, at least some of these other policy concerns might be incorporated into estimates of costs and benefits through more sophisticated economic analysis. This suggests that there is potentially some benefit to broadening the definition and inclusiveness of costs and benefits to encompass additional factors normally considered by public policy makers. For example, one could introduce weights to reflect policy concerns about the distributional implications of environmental outcomes across different population groups. Similarly, uncertainty and irreversibility concerns might be accommodated by adjusting conventional benefits estimates.

But all of these factors must be introduced quantitatively and monetarily in order to accurately reflect them in the actual tax rates promulgated. This is no small feat in light of the fact that, at least presently,

valuing the benefits of environmental regulations in monetary terms is a rare event. Moreover, some policy goals cannot realistically be embodied in corrective tax rates; for example, the tax rates necessary to satisfy the objective of zero risk of exposure to hazardous waste essentially would be infinite.

It is thus unlikely that even far more sophisticated economic analysis will systematically, much less quantitatively, capture all of the myriad goals and factors that are actually weighed in practical environmental policy making. Because of this, the costs and benefits typically captured by economic analysis of a regulation will often be a subset of the criteria used by decision makers in formulating environmental policy. If so, this has profound implications for using corrective environmental taxation as regulatory tools. The great advantage of corrective taxes is that they cause private sector decision makers to weigh the social costs and benefits of their actions by inserting the missing values of pollution damages into their calculations. As long as the explicit social goal is to balance economic costs and benefits, corrective taxation is indeed a powerful tool.

But when public policy decisions are guided by a broader set of concerns that are difficult to reflect in monetary tax rates, the great advantage of corrective taxation becomes somewhat of a liability. This problem is similar to the discomfort policy makers express about the necessity of ceding control over outcomes to polluters when using economic incentive systems. Here, corrective environmental taxes require the regulator to embrace as the overriding policy goal a direct balancing of costs and benefits as measured in practice, and essentially to ignore other policy considerations that are more difficult to express in quantitative, much less monetary terms.

Equity Justification for Corrective Taxes Often Fails in Practice

Yet another reason for the infrequent use of corrective environmental taxation in practice is that satisfying the need for an equity justification is far harder in reality than in theory. Recall that more than efficiency enhancement is required for policy makers to be comfortable and confident in using corrective taxation. In particular, taxes impose different distributional outcomes than do other available policy instruments because they charge polluters for residual (but efficient) pollution. The traditional justification for this is the polluter-pays principle, which casts the tax liabilities not as an added tax burden on polluters, but as an "invoice" for the damages they cause.

This is all fine in theory. As noted above, however, a significant problem in practice is that quantifying and valuing environmental pollution damages is expensive, difficult, and often extremely controversial. Even on its own terms, trying to convert numerous hard-to-measure impacts of pollution on environmental resources that are often very far removed from goods and services traded in the market is a task fraught with significant uncertainties and substantial information requirements.

Moreover, applying even the best techniques for valuing many types of pollution damages often results in a wide range of monetary estimates. Someone has to undertake the unenviable task of selecting and defending a specific value to use in forming the environmental tax rate. For example, estimates of the value of avoiding a statistical death among a large group of people range from hundreds-of-thousands to tens-of-millions of dollars. It matters a great deal in setting the actual corrective tax rate whether figures from the bottom, the middle, or the top of this range are used, several orders of magnitude to be specific. Those paying the tax naturally will argue for the low end, while defenders of the environment will press for the higher end. There are few proponents of compromise in this debate.

Perhaps more significant is that some participants in the policy making process disagree with the basic notion that many environmental resources harmed by pollution can be valued by the methods and procedures economists currently use. Hence, in many cases the debate is less about the monetary estimates

themselves than the fundamental ethical stance implied by placing dollar values on environmental resources and human lives.[9]

Even if some agreement on rough dollar values of environmental damages can be obtained, still more controversy surrounds the practice of discounting future effects to the present. Many environmental regulations offer risk-reduction benefits that accrue far into the future. The present values of these benefits are significantly affected by the discount rate used, sometimes by orders of magnitude. Hence, uncertainty about the precise discount rate, even what appears to be a relatively small range of possible values, say 2 to 4 percent, can radically alter any tax rates based on those discounted benefits. Even more troubling is that some question the entire ethical foundation for discounting over long time horizons when future generations are not present to participate in policy decisions. All of this introduces yet more sources of uncertainty about the appropriate magnitudes of environmental taxes and an additional reason for there being extremely wide ranges of defensible rates.

Throughout all of this, as economists repeatedly and correctly point out, policy decisions must be made. Regulators deciding between different pollution-control alternatives either will require estimates of the value of environmental harms to assist them, or in the process of making those decisions without explicit values for environmental damages, their choices will reveal implicit values for them as a result. Nevertheless, the issue is not so much that the controversy and difficulty of placing values on environmental damages adds another dimension to an already complex policy-making task. Rather, it is that significant uncertainty about the values of environmental damages translates directly into some doubt about whether the tax liabilities are really accurate "invoices" for environmental damages. This renders what was a very powerful theoretical equity argument in favor of taxes -- that the taxes are really only charges polluters must pay for the damages they cause -- far less convincing in reality.

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[9] See S.J. Kelman, What Price Incentives? Economists and the Environment (Boston: Auburn House, 1981) for a thorough review of the philosophical arguments against the use of corrective taxation.

3. Using Environmental Taxes to Achieve Predetermined Regulatory Targets

The fact that true corrective taxation has seldom, if ever, been used in environmental policy has not been ignored by economists. Indeed, largely in response to the often fundamental conflicts between the way policy makers normally approach environmental regulation and the way traditional corrective taxes operate, a more restricted type of environmental taxation has been developed. The hope is that this new version might avoid at least some of the more significant problems that have plagued attempts to use true corrective taxes in practical policy making.

This new incarnation of environmental taxation is referred to as the as the "standards and charges" approach[10]. Because environmental regulatory policy tends to be formulated by establishing acceptable outcomes and then exploring various possible approaches to achieve them, the standards and charges ("taxes" in the terminology of this paper) approach suggests that taxation could be used as an alternative to command and control to achieve a predetermined regulatory goal more efficiently.

This new version of environmental taxation normally is advanced in the context of a pollution problem to which a number of sources contribute. For example, suppose 10 sources emit a total of 200 units of a particular air pollutant in a region. To enhance air quality in the area, the regulatory authority might decide, based on a number of policy criteria, that total emissions from these sources should be only 100 units. One way to achieve this would be to mandate a 50% reduction in emissions from each of the 10 sources. Another way to accomplish this goal would be to tax emissions from these sources at a rate sufficient to reduce the total by the required 100 units, setting the tax rate not at the value of marginal environmental damages but instead at a level that encourages sufficient controls by all sources collectively to meet the predetermined emissions target.

Of course, both approaches will achieve the policy goal. But when emission control costs differ across the various sources in ways not known by the environmental authority, the across-the-board limitations

[10] See Baumol and Oates (1988), supra note 2, Chapter 11.

of command and control will impose compliance costs greater than necessary, because marginal control costs will not be equated across sources. As seen earlier, however, the tax approach will minimize the cost of achieving the target reduction in pollution by equating marginal control costs across sources. This will ensure that emission controls throughout the industry are undertaken in a least cost manner, but it does not require the environmental authority to gather and process detailed information on compliance costs source-by-source, which would be necessary to accomplish the same result using command and control regulation.

Admittedly, the predetermined policy target might be either too stringent or too lenient relative to the fully optimal solution. For example, the optimal amount of emissions actually might be 80 units, so a true corrective tax aiming to achieve that result would be greater than that necessary here to reduce emissions to the target level of 100 units. Alternatively, the optimal level of emissions might be greater than 100, say 120, so that the true corrective tax in this case would be less than that used to meet the predetermined regulatory target of 100 units. But given that the acceptable overall level of emissions from these sources has already been decided, setting a tax at a rate sufficient to attain this goal may not be truly optimal, but will nevertheless have a potentially significant cost-minimization advantage over command and control.

One objective in formulating this new version of environmental taxes is to avoid some of the more troubling difficulties encountered in trying to use true corrective taxation in environmental policy. And taxes intended to satisfy a predetermined regulatory goal do indeed skirt the difficulties of setting tax rates based on hard-to-value environmental damages, and the often intractable conflicts between overall policy goals and the single net-benefits maximization objective that underlies corrective taxation. Because the target is no longer the full social optimum, tax rates need only be those necessary to call forth from the industry sufficient emission control to reach the environmental improvement goal. Using taxes in this way makes no reference to valuing damages and, by explicitly adopting the predetermined target, completely erases any conflicts between environmental policy goals and the operation of taxes.

Of course, in using even this more limited form of environmental taxation, one must still wrestle with the many complexities of the world, such as variations in the amount of damages from different pollution sources, and the difficulties inherent in mitigating non-point source pollution problems. Moreover, most environmental policy goals tend to be specified in terms of tangible and relatively easily monitored outcomes that are best described by quantitative environmental indicators and measurable emissions of pollutants, or by the application of technologies that are understood to achieve a particular quantitative goal. Hence, command and control regulations tend to be written in terms of the ways these policy targets are specified and measured, for example, the maximum concentration and volume of a particular pollutant from a specific plant per day, or the use of a particular air emission control technology.

Environmental taxes, however, are monetary charges that influence the decision making of polluters, but do not constrain the physical outcome. Finding the tax rate that will attain the overall target level of emissions and pollution, therefore, could require considerable study. Some experimentation and adjustment of the tax rates would probably be required to reach satisfactory results under this "standards and charges" redefinition of environmental taxes.

Nevertheless, the empirical challenges one faces in using this new version of environmental taxation are not inherently different from or more difficult than those regulators confront every day in the process of fashioning workable policies to address real-world environmental problems. For example, deciding exactly what to tax and determining whether a single tax rate or several will be required to account for the unequal environmental impacts of different sources are complexities mirrored in one form or another in any practical approach to address the underlying environmental problem. When multiple tax rates might be needed, the same circumstances would also require a marketable permit system to establish more complex rules than one-for-one permit trading across emission sources, and they also would suggest more complex command and control strategies than one-size-fits-all.

The efficiency case for using environmental taxes as redefined in the standards and charges approach to achieve predetermined policy goals is thus a reasonably strong one. These taxes can generally achieve an environmental target at lower cost than command and control approaches that do not account for differences in control costs across polluters. Such taxes also offer regulators significant administrative benefits over more traditional source-by-source, command and control regulation. Under the latter approach, trying to achieve the regulatory goal at anything even close to the lowest cost requires the regulator to collect large amounts of information on each source's control costs, and then to promulgate standards of varying stringency for different sources to reflect differences in control costs. When using taxes, however, the regulator simply searches for the tax rate that is sufficient to achieve the policy target, relying on the individual emission sources to compare their own control costs to the tax rate to reach the minimum-cost solution.

With all of these advantages, and far fewer of the problems that have hobbled attempts to use true corrective taxation, one might expect this new type of environmental tax to receive a warm welcome from policy makers. Unfortunately, this new version of environmental taxes has some practical problems and limitations that significantly affect its attractiveness to policy makers. The most important of these are the loss of the equity justification for using taxes as opposed to other forms of regulation, and the somewhat restricted applicability of the approach.

Loss of the Equity Justification for Environmental Taxes

Although the efficiency advantages of using taxes instead of command and control to encourage multiple polluters to achieve a given environmental policy target cost effectively are clear, regulators still must defend the use of environmental taxes on equity grounds. As before, the efficiency enhancement of taxes usually is not sufficient to justify their selection over other regulatory instruments because taxation forces polluters to bear the burden of both emission control costs and additional taxes. In general, the smaller the efficiency gain of the tax approach relative to conventional command and control regulation, the less compelling will be an efficiency-based argument for imposing the extra tax burden on polluters in addition to

the emission control costs. Put another way, it is difficult to choose taxes over command and control regulation when the cost savings are small and the added tax burden is large.

Far more important, however, is that the cost-minimizing property of taxes in encouraging multiple polluters to reach a predetermined environmental target at the minimum cost is possessed identically by a marketable permits system. The two incentive systems -- price-based taxes and quantity-based permits -- each achieves the policy target by presenting polluters with the appropriate incentives. Taxes do so by explicitly pricing pollution. Permits accomplish the same result by allowing trading of pollution rights.

Because the tax rate necessary to achieve the regulatory target will be the same as the market price of permits, both approaches will attain the overall regulatory goal at minimum cost, and both will equally outperform traditional command and control regulations by improving on the insensitivity of command and control to variations in control costs across different sources.[11] The choice between these two systems on efficiency grounds, therefore, revolves around subsidiary considerations, such as favoring taxes when transaction costs involved in trading permits are high, and using permits when there are difficulties and uncertainties in adjusting and fine-tuning the tax rate to achieve the policy target.

In the absence of any clear efficiency-based reasons for using taxes instead of marketable permits to achieve a predetermined policy objective for multiple pollution sources, it becomes paramount to have a convincing equity justification for taxes. But it is at this point that the new version of environmental taxes runs into deep trouble. Recall that the confidence regulators have in defending the distributional consequences of tax approach flows mainly from the polluter-pays principle. For true corrective taxation, the theoretical equity argument is strong because a polluter's tax liability is simply an invoice for the environmental damages it causes.

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[11] Taxes and marketable permits are also superior to command and control regulations in the long run because these incentive-based options price pollution that the policies still allow. If this is not priced, too many firms will enter the industry in the long run, which will then require tighter per-source standards to meet the policy target. See D.F. Spulber, "Effluent Regulation and Long-Run Optimality", Journal of Environmental Economics and Management, Vol. 12, No. 2, June 1985, pp. 103-116, for a discussion of this and related points.

The problem for taxes that seek to achieve a predetermined policy goal is that the tax rate necessary to reach the regulatory target may bear no obvious relationship to the marginal social damages of pollution. Hence, when taxes and permits both achieve the overall target level of environmental improvement, the equity case for using taxes instead of marketable permits is weak. The regulator cannot easily use the polluter-pays principle in support of taxes, because there is no basis for arguing that the tax bill equals the environmental damages. This is especially troublesome when marginal benefits fall short of marginal costs at a predetermined policy target. Using an environmental tax in this case would impose a tax exceeding the cost of the pollution damages.

This is not to say that one cannot mount an equity justification for using taxes in pursuit of a predetermined policy goal. Rather, the problem is that the tax rate is set to achieve the regulatory target, so it bears no explicit or necessary relationship to the level of environmental damages. Hence, to successfully defend the distributional effects of using taxes, the regulator must develop a secondary and independent equity justification based presumably on the value of environmental damages at the predetermined policy target. But this is at least some of what the entire recasting of environmental taxes into the standards and charges framework was designed to avoid.

By comparison, the equity case for using marketable permits is quite straightforward. The permits normally are assumed to be distributed to emission sources in amounts equal to their allowable emissions under a command and control regulation that achieves the same overall level of pollution control. Hence, no one will oppose using these grandfathered marketable permits instead of command and control, because voluntary trades of permits cannot make anyone worse off. Therefore, no equity justification is required for using marketable permits instead of command and control.

But in substituting taxes for a command and control regulation, there is no guarantee that individual emission sources will not be worse off. In fact, relative to command and control, taxes seem to impose almost perverse equity consequences. Consider how a low control-cost emission source fares when taxes are

substituted for command and control. Under the latter approach, this source reduces emissions at a modest cost to meet the control requirements. When taxes are then substituted, this source adopts even more stringent pollution controls and pays taxes on any residual emissions. This source clearly must be worse off under taxes than command and control. High control-cost sources, on the other hand, could be either better or worse off under taxes relative to command and control depending on how much they save by paying taxes instead of controlling emissions and the size of the tax bill they now owe for residual pollution. Thus, in the process of obtaining efficiency enhancement -- shifting controls from more- to less-expensive sources -- taxes effectively penalize low-cost firms and potentially reward high-cost ones.

It is thus easy to understand why marketable permits will be preferred over taxes by regulators and the affected industries. Marketable permits are a direct quantity-based method of achieving target levels of environmental improvement at minimum cost, and if the permits are initially distributed without charge, the approach does not require any equity justification relative to command and control. Taxes similarly enhance efficiency but require an independent equity justification. In a sense, marketable permits "dominate" taxes because they accomplish the efficiency enhancement regulators seek, without the need to search for the appropriate tax rate, and, perhaps more significantly, without the burden of defending potentially large distributional consequences, a task rendered quite difficult because there is no necessary relationship between the tax rates necessary to achieve the predetermined policy goal and the resulting level of environmental damages.

Restricted Applicability of the Approach

Recasting environmental taxes into the standards and charges framework has another more subtle consequence. As noted earlier, this new version of environmental taxes is most appealing when policy makers establish an overall target level of emissions for multiple pollution sources that contribute to an environmental problem. For example, many sources of CO_2 contribute to global climate change, and reducing overall emissions clearly could benefit from approaches that take advantage of possibly large differences in control

costs across sources. Similarly, emissions from many sources in an airshed all combine to damage air quality in the region, so it makes sense to use taxes to achieve predetermined air quality improvement targets at lower cost.

Although situations in which multiple sources contribute to a given harm are common, they nevertheless are only a subset of all environmental problems. For example, setting safe drinking water standards or developing risk-reduction guidelines for pesticide use, much less regulating hazardous waste management, do not fit the multiple sources-single harm mold. In these cases, policy makers are more concerned with risk management at the level of individual occurrences or with pollution damages caused by a particular source independent of those generated by other sources. In such situations, the primary mechanism by which taxes provide efficiency enhancement -- cost minimization across multiple sources that contribute to a single harm -- is no longer relevant.

For example, when the desired result is for all hazardous waste disposal facilities to undertake various design and other measures to reduce the probability and environmental impacts of toxic substances releases, it makes no sense to try to cast this in terms of a single harm to which all such facilities contribute. Instead, each source poses independent risks. Similarly, if the environmental problem is emissions of pollutants from a specific industrial source, no other facilities contribute to the problem, so the across-sources cost minimization provided by taxes no longer applies.

Of course, in all cases it still makes sense to try to achieve policy goals at the lowest cost, so one can imagine using the tax approach to encourage individual polluters to reach their policy targets cost effectively. But incentives to minimize costs will be present under command and control regulations that directly specify these pollution limitations. As long as regulators are equally flexible in defining and setting standards under command and control as they are in determining what to tax and at what rates, both approaches will attain largely the same environmental goals at similar cost.

What all of this means is that in a host of real-world circumstances, regulators gain little by doing anything other than promulgating their policy targets in the terms in which they are normally expressed. If the goal is to reach a given reduction in the amount and toxicity of the emissions from a pollution source, specifying this as an emission standard will satisfy the objective directly. The regulator could also tax the facility at a rate sufficient achieve the policy goal, but the result would be the same. Thus, when across-source cost minimization is not relevant, the major advantage of the standards and charges version of environmental taxes evaporates. Theoretically, to satisfy a predetermined policy target for an individual polluter, a marketable permit system collapses to a performance-based standard because only one permittee exists, and a tax, after fine-tuning to meet the predetermined policy goal, offers little, if any, efficiency enhancement over intelligently conceived command and control.[12]

Because the compelling efficiency advantage of the standards and charges notion of environmental taxes is relevant only in multiple sources-single harm situations, the case for using such taxes is largely confined to this subset of situations. It is therefore somewhat ironic that the great advantage of this version of environmental taxation only applies in precisely a set of circumstances where another incentive-based instrument, marketable permits, tend to be more attractive to regulators. It is even more ironic that only in these multiple sources-single harm circumstances does it make sense to use marketable permits at all because, for marketability to mean anything, there must be multiple sources among whom permits are traded.

4. Where Do We Go From Here?

Given the many reasons for environmental taxes not being used in policy making, the prospects for their adoption as environmental regulations in the future might seem quite bleak. This impression is partially the result of having dwelled so long on the practical difficulties policy makers have encountered in trying to

[12] It is possible to argue that an additional reason for the greater efficiency of taxes relative to other approaches is that taxes charge for residual pollution. This ensures the appropriate long-run entry conditions for polluting industries. In practical policy making, however, this is not a very compelling argument. Moreover, it is not clear that these considerations are relevant in the single-source/predetermined target case, especially if the policy goal is more stringent than is optimal from an economic perspective.

use taxes. The goal of this paper, however, is not just to diagnose these problems, but also to indicate how at least some of these policy and economic issues must be resolved before using taxes as environmental regulatory policies can become a reality.

Prognosis for the Use of Environmental Taxes

The practical difficulties of using taxes as environmental regulations identified here suggest that any reasonable expectation of their adoption in the future will require regulators to approach matters in a number ways fundamentally different from those used in the past. The first step, of course, is to ensure that regulators have realistic expectations regarding the operation and effects of corrective taxes. But even with this point of departure, it still is unlikely that taxes will be the environmental regulation of choice in all practical circumstances. Depending on the circumstances, there will always be some tension between multiple policy goals and the fundamental properties of corrective taxation, and taxes will require hard work to implement and to justify on equity grounds. Nevertheless, approaching their use with realistic policy expectations will go a long way toward making tax-based environmental regulations a reality. Beyond that, the central issue will be where economists and policy makers might find the best candidates for using environmental taxes.

Considering first the use of taxes in pursuit of predetermined regulatory goals, the outlook is reasonably optimistic if the dominance of marketable permits can be overcome. Admittedly, the central advantage of these cost-minimizing taxes is limited to situations in which multiple sources together cause a pollution problem. But within these confines, taxes could be used if they can be defended as superior to marketable permits. Hence, good candidates for these sorts of taxes are situations in which the transactions costs involved in marketable permits are high, both in initially allocating them and in accomplishing trades among permittees.

Assuming that there is an implementation-based reason for using taxes instead of permits to pursue a predetermined regulatory target, the distributional outcome of taxes will still require justification. From this political perspective, taxes are thus less likely to be chosen over permits when a relatively small number of

sources face large tax liabilities. On the other hand, when large numbers of sources face relatively small individual tax bills for residual emissions, taxes probably will be more acceptable. They will also be more attractive to regulators and polluters when the cost savings over command and control are substantial.

But multiple sources-single harm situations are only a subset of all practical environmental problems. The prospects for using environmental taxes in more general circumstances must therefore lie in returning to the original corrective environmental tax formulation. Recognizing this, it is sometimes argued that one way to avoid some of the major difficulties in using true corrective taxation is to supplement existing standards-based regulations by levying taxes on the residual emissions allowed under the command and control requirements. The command and control regulation achieves the emissions reduction the regulator desires, while the tax charges sources for the damages that remain. Clearly, this would be consistent with true corrective taxation as long as the tax rates approximate the social damages the residual pollution causes.

This hybrid system does indeed avoid some of the major problems in using environmental taxation in practice, such as the loss of control over outcomes and conflicts between multiple policy goals and the exclusive maximization of net benefits implied by taxes. But it should be readily apparent that it would be difficult to argue for such an arrangement unless one could point to plausible environmental improvements that might result. After all, the extra environmental tax is supposed to be an environmental regulation.

One possible environmental benefit of adding taxes to existing regulations might be that these taxes will be even more stringent, so that additional controls and environmental improvement will result. But this seems unlikely, because there is little reason to think that regulators who are unwilling to promulgate sufficiently strict command and control regulations will somehow be comfortable doing so using environmental taxes.

Because conventional proposals to add taxes on top of existing regulations often do not have strong regulatory arguments in their favor, proposals to use these hybrid arrangements tend to be viewed as obvious ploys to gather more revenues rather than produce significant environmental benefits. This is not to say that

using multiple regulations is unwise. Rather, it is that without a clear regulatory justification for supplementing existing rules with environmental taxes, doing so appears to be motivated by the tax revenues generated, not the environmental improvements that will result. Hence, although using corrective taxes in tandem with other regulatory instruments is perfectly legitimate, successfully defending them as regulatory tools is really not much different from justifying their use alone.[13]

Ultimately, to make any tangible progress in applying true corrective taxes in practical environmental policy making, regulators will have to pick their battles wisely. Some situations simply are not realistic candidates for corrective taxation, so it is best to avoid wasting financial and political resources on them. For example, regulators are not likely to be comfortable ceding control to polluters when the environmental problem involves highly toxic substances that produce serious harms to human health and the environment. Similarly, when policy makers weigh a number of policy goals other than measurable costs and benefits, unless these can be incorporated into the actual tax rates, environmental taxation is unlikely to be used. Regulators should therefore focus attempts to use corrective taxation on situations where policy makers are relatively comfortable with outcomes based substantially on a private sector weighing of costs and benefits, supplemented of course by the taxes. Positive amounts of residual pollution that are not cost effective to avoid must be acceptable, as must be the uncertainty about exact outcomes inherent in ceding control to polluters.

Policy makers should also focus on situations in which using taxes over other regulatory approaches is likely to generate significant gains in efficiency. There is little point to investing large efforts in using a

[13] To see this, consider a more realistic example of a hybrid regulatory system under which traditional command and control standards are supplemented with the opportunity to exceed the specified limits of those regulations by paying a fee per unit of pollution. The attractiveness of this arrangement is that it allows sources flexibility when full compliance is unexpectedly costly for some reason or another. But this is ultimately the same as the general advantage of using taxes over command and control in that it uses private, decentralized decision making about emission control based on a price of polluting instead of centralized and information-intensive decision making by the regulator. Hence, this situation will not be any easier to justify than using a corrective tax by itself.

new regulatory approach where the gains from doing so are small. Hence, the case for using taxes will be easiest to make when there is strong evidence that decentralized decision making about pollution control based on corrective taxes will substantially reduce total costs and increase overall environmental benefits. In practical applications, the blanket theoretical assertion that taxes will be superior to other approaches generally is not a good substitute for a convincing empirical demonstration that identifies the source and magnitude of the efficiency enhancement to be gained.

Attempts to use corrective taxes in practice will also meet with greater success when regulators are reasonably confident that tax rates can be devised that bear some relationship to the pollution damages, and certainly that they are not vastly greater than the harms caused. Hence, what is needed in the environmental policy making arena is a more concerted effort to focus on benefit-valuation issues earlier in the regulatory process to avoid foundering later for lack of confidence in the tax rates. While this is not new advice, it is worth emphasizing. If policy makers have deep reservations about "pricing" environmental harms, they will not use taxes as regulatory instruments.

In addition to focusing on regulatory situations that are compatible with corrective taxes and where there is a reasonable expectation that tax rates can bear some discernable relationship to pollution damages, policy makers must then engage in fair comparisons of alternative policies. As is true of any regulatory intervention in practice, real-world corrective taxes inevitably will be inefficient relative to the optimal textbook outcome. Because corrective taxation's claim to fame is its efficiency, the approach seems to fail on its own terms in policy makers' eyes.

But correcting the problem of unfair comparisons involves more than convincing policy makers that parallel evaluations of alternative approaches are critical to using taxes in practice. At least part of the blame belongs to those who tout the superiority of corrective taxes in general, but then criticize specific attempts to use them in the messy and imperfect world of policy practice. An extreme example of this is the insistence that to obtain the truly optimal solution, one must set the tax rate equal to the marginal social damages at the

optimal level of pollution, not the current level, which requires regulators to know all of the control cost information for polluters as well as how the value of damages changes as pollution levels vary.

Of course, regulators never have enough information to ensure that interventions are completely optimal, whether command and control approaches or market-based systems, but this does not prevent them from acting. Moreover, worrying about any differences between the value of marginal environmental damages initially versus at the optimal level seems overly cautious, given the current state of practical environmental benefits analysis. Regulators consider themselves lucky to have quantitative estimates of risk reduction, uncertain and imprecise as they often are in practice. Hence, although there may be exceptions, it is probably reasonable to assume for the moment that marginal social damages, initially and at the optimal level, both probably lie within the wide confidence bands provided by practical attempts to quantify and value environmental harms.

Finally, there is little to be done about the fundamental conflict between the desire to use environmental taxation to collect revenues for the government and the need to justify such taxes as sound environmental regulatory policy. In general, situations ripe for collecting large revenues using excise taxes are unfortunately quite different from circumstances in which a corrective tax is most useful in addressing an environmental problem.

The resulting tension will never be resolved. On the one hand, the desire to collect revenue will always pull policy makers toward broad-based taxes levied on existing market transactions that spread (hopefully) a large tax burden over many entities. But these are very difficult to defend as worthwhile environmental regulatory policies. On the other hand, policy makers wishing to use true corrective taxation as a regulatory tool primarily for its efficiency properties will view revenue generation as an incidental -- perhaps even a politically unwanted -- byproduct.

It is tempting to argue that perhaps some middle ground can be found where taxes that raise significant revenues are also sound environmental regulatory policies. This is an empirical issue, of course,

but one should never lose sight of the fact that one is trying to satisfy two goals with one instrument, in this case raising revenues and improving the environment. Although it is conceivable that a corrective environmental tax could fulfill both objectives, the record to date is not encouraging.

Hence, rather than setting out to try to find instances in which one can generate large amounts of revenues with an environmental tax, it is probably more productive to discard the goal of revenue generation initially so that practical attempts to use corrective taxation can first be justified as beneficial environmental regulatory policies. Once experience with using this regulatory approach is sufficiently broad and deep, some attention to its revenue-raising potential might be entertained, but never to the point of eclipsing the basic requirement that environmental taxes first be prudent and effective regulations.

Where these issues and considerations point for using environmental taxes in practice should be fairly obvious to observers of environmental policy. Clearly, pollution problems for which the explicit or implicit goal is largely zero- or extremely-low risk of exposure or harm, such as hazardous waste management and drinking water standards, are not good candidates for environmental taxation. Similarly, risks that result in serious human health consequences are also not likely to provide the conditions necessary for using environmental taxes, so it is best to avoid problems posed by, for example, pesticides and highly toxic substances.

Instead, chances are far better for using pollution taxes to control air and water emissions that result in general degradation of ambient environmental quality. For example, emissions of volatile organic compounds, particulates, and other substances in particular regions pollute the air, causing significant and widespread damage to human health and the environment. Similarly, effluent discharges can substantially impair the quality of waterways, reducing the ecological, commercial, and recreational value of these resources. In these cases, while the damages may be significant, they are large primarily because of the substantial numbers of people and environmental resources affected, not because of the intensity of the harms on an individual basis. Moreover, these are situations in which positive amounts of emissions or effluent are

politically acceptable, and where there may be significant differences in pollution abatement costs across many different sources. Hence, the traditional air and water emission-control programs are much more likely to provide opportunities for using pollution taxes than other areas of environmental policy.

Why Bother With Environmental Taxes?

In light of all of the problems policy makers confront in attempting to use environmental taxes, much less the hard road that lies ahead for those who continue to pursue this approach to environmental regulation, it is perfectly legitimate to ask why regulators should bother with taxes at all. After all, policy makers have been reasonably successful over the years using traditional command and control regulation. Moreover, while there certainly are some exceptions, many applications of command and control regulation are not nearly as obtuse and insensitive as the pictures painted by detractors would indicate. Hence, given that command and control is not quite as bad as its opponents suggest and that economic incentives are not quite as good as their proponents wish, the gains to be had by shifting from the former to the latter normally are overstated.[14]

Nevertheless, there are several reasons for continuing to try to use corrective taxes. First, while substantial environmental improvements have occurred over the past several decades, further gains are likely to be obtained at possibly rapidly increasing costs. Hence, the efficiency-enhancing properties of incentive systems in general will become more important in the future. Furthermore, as the emphasis on efficiency in obtaining environmental improvement intensifies, policy makers will find that the applicability of many incentive systems other than corrective taxation is confined to subsets of environmental problems. For example, marketable permits are really only applicable to situations in which multiple sources contribute to a single harm. Similarly, deposit-refund schemes, such as beverage container return systems, are useful when one needs to discourage actions by numerous entities that are often individually insignificant but collectively harmful, and enforcing other regulatory approaches is prohibitively expensive.

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[14] W.J. Baumol discusses some of the biases in empirical estimates of the superiority of incentive systems in "Toward Enhancement of the Contribution of Theory to Environmental Policy", Environmental and Resource Economics, Vol. 4, 1991, pp. 333-352.

But the only incentive system with general applicability across the wide spectrum of actual pollution problems is corrective taxation. At least in theory, the approach can be applied to any individual- or multiple-source pollution problem. As a rule, if the harm can be measured and the chain of causation can be traced back to the entities responsible, a corrective tax conceivably can be used to address the problem. Hence, to the degree that policy makers turn to incentive systems more often in the future for their efficiency properties, they will be driven by necessity to corrective taxation because of its broad applicability. Of course, attempts to use taxes in the future still may fail because of the many policy conflicts and practical difficulties discussed here.

A second advantage of corrective taxation in the long run is its inherent ability to tap detailed and diversely-held knowledge, information that would be very costly for the regulatory authority to gather, in pursuit of social environmental goals. Of course, this is the advantage most often cited in support of market-based approaches. As argued here, however, the benefit of "harnessing market forces" in environmental policy is not entirely unqualified. In many cases, policy makers are not willing to cede control over the environmental outcome to polluters, and are uncomfortable trying to reflect certain policy concerns in monetary tax rates. But where regulators are satisfied with outcomes generated purely by weighing quantified costs and benefits, delegating the detailed decision making down to the individual polluter level does seem to offer significant advantages over continuing to rely on regulatory standards to accomplish the same goals.

This is not to say that developing tax rates for specific circumstances will necessarily be simple. Instead, the point is that if the overall policy goal is to tailor individual pollution control decisions based on quantified costs and benefits, it seems an appropriate division of labor for the regulatory authority to focus on developing information about, and monetary estimates of, the environmental damages pollution causes, and to allocate the task of making numerous specific decisions about pollution control to those in the best position to make them.

Realizing the fruits of this widely touted advantage of corrective taxes, however, depends critically on the willingness of regulators to allow the system to function as intended. Whether or not the ability of corrective taxation to cause private-sector entities to weigh costs and benefits and to adopt pollution controls accordingly, is an advantage therefore depends fundamentally on the degree to which policy makers' broader policy objectives can be satisfied by setting prices for environmental harms and allowing polluters to make their own choices.

Finally, of all possible regulatory approaches for addressing environmental issues, corrective taxation focuses most clearly on the benefits side of the problem. Economists criticize many environmental regulations as being too costly, at least from the perspective of the net social benefits they produce. Hence, by making the benefits almost the point of departure in environmental policy making, using corrective taxation makes it harder to ignore cases in which proposed regulations impose far higher costs than the benefits they provide.

Of course, one can argue that many benefits of environmental regulations are difficult to quantify, much less to value, but that they nonetheless do exist. Furthermore, one can note that regulators often weigh more than just quantifiable costs and benefits in making real world environmental policy. While both points certainly are valid, the emphasis corrective taxation places on the benefits of regulatory interventions indicates what those unquantified environmental effects and other policy concerns must be worth to justify these actions in economic terms. In the longer run, therefore, using corrective taxation could have the unintended side effect of clarifying, if not quantifying, the economic and non-economic tradeoffs regulators face in making practical environmental policy for the nation.

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