INTERNATIONAL:

MARKET-BASED INCENTIVE INSTRUMENTS FOR POLLUTION CONTROL*

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The authors wish to thank the Tax and Tariff Commission, Ministry of Finance, Republic of China for its financial support to the Harvard International Tax Program which enabled us to undertake this study. Comments by the staff of the Tax and Tariff Commission on an earlier draft of this work were very helpful and were greatly appreciated. Discussions with our Harvard colleagues, Robert Stavins and Theodore Panayotou, have significantly improved our understanding of the design and operation of market-based incentives to control environmental damage. A special thanks to Ana Lucia Santos, Rachaneephan Yuktasevi and Efeng Huang who, as graduate students at Harvard, completed their thesis in this field of study, and to Mwana Lugogo, who provided key assistance in the completion of the final reports.

ABSTRACT

The use of market-based incentives (MBIs) as mechanisms for influencing pollution abatement has increased greatly in recent years. This trend reflects the realization that the integration of economic and environmental decision-making will induce the private sector to take steps to reduce their pollution emissions levels. Market-based incentive instruments may be broadly classified to include environmental taxes, investment tax incentives, tradeable permits, user charges and deposit refund systems. Until now, policy-makers worldwide have continued to place greater emphasis on the use of investment tax incentives since they seem to more effectively balance environmental considerations with concerns about industrial competitiveness. It is becoming increasingly apparent, however, that other MBIs may be more effective mechanisms for influencing pollution abatement in certain circumstances. This report reviews the theoretical foundations for idealized pollution control MBIs. It then focuses in particular on the way in which environmental taxes, deposit refund systems and tradeable pollution permits may be more suitable instruments for inducing pollution abatement behaviour. A number of international examples of the implementation of such policies are reviewed.

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I. INTRODUCTION

Assessments of the fiscal structure, operational mechanism and economic impacts of investment tax incentives for pollution control point to the challenge of designing fiscal instruments for pollution control purposes. Much of this challenge lies in designing an administratively and politically acceptable market-based instrument. This paper discusses alternative market-based instruments for pollution control.

Section I is a review of the theoretical foundations of MBI instruments. The discussion stresses the disadvantages of the traditional regulatory approaches used to control pollution and the advantages of the MBI approach. Section II describes three MBI instruments — environmental taxes, deposit refund schemes and tradeable pollution permits. Aspects of their design and administration are also presented.

* See for the first article on pollution control the October 1992 issue of the Bulletin at 483.

II. THEORETICAL FOUNDATIONS OF MBIS

A. *The demand for MBIs*

Market-oriented pollution control strategies have emerged due to a realization that traditional regulatory approaches are inefficient for most pollution abatement.[1] First, the spending required in order to comply with increasingly stringent environmental laws and regulation is becoming a major cost of production. The US Environmental Protection Agency (EPA), for example, estimates that over $100 billion is spent annually to comply with federal regulations.[2] Governments are, therefore, investigating control options and mechanisms that would maximize the pollution abatement per dollar spent.

Second, it is increasingly clear that the costs of installing and operating the necessary control equipment vary greatly both within and between industries. To get the most efficient (least cost) reduction in pollution, industries with the lowest abatement costs should reduce their level of pollution with due compensation from industries with higher abatement costs. To provide a sense of the cost variability, we refer to a 1992 study that estimated the investment in pollution abatement equipment and operating costs of pollution control activities by manufacturing industries.[3]

The study indicated that pollution control expenses form only a small part of the total costs of most industries. Expenses are concentrated in a relatively small number of activities, with three sectors – chemicals, petroleum refining and primary metals – accounting for 55 percent of the total spending. Investment in pollution abatement consumes more than 20 percent of the total investment for the pulp and paper, petroleum refining and primary metals industries. The primary metals industry has the largest share, at slightly more than two percent of the total expenditures on pollution abatement.

Third, concerns over the impact of environmental regulations on the strength of the national economy and the nation's ability to compete in international markets is acute. Consequently, policy-makers place an increasing emphasis on the degree and type of burdens placed on businesses and individuals.

B. *The economics of MBI instruments for pollution control*

Efficiency arguments in favour of public intervention to mitigate pollution problems are well established.[4] Fundamentally, it is recognized that market failures do occur, with the end result that the true social cost of a product or physical input is not reflected in its price. These failures are termed "externalities". An external effect occurs when the welfare of a household depends not only on its own actions, but also on the actions of others. If the activity imposes an adverse impact on others, it is termed a negative externality. Polluting activities are a prime example of negative externalities.

When there are pollution externalities, the market mechanism fails to induce the polluter to consider the costs on others of his/her activity. In other words, a free market without corrective intervention would result in pollution emissions in excess of the "optimal" levels. More specifically, an industry would pollute until its private marginal benefits equalled its private marginal cost. An externality is manifest when the welfare of those hurt by the pollution, expressed in terms of social benefits and costs, does not influence the polluters because the costs do not directly affect their decisions to pollute (i.e. the costs of environmental damage are external to the polluter).

Economic theory suggests that if the monetary value of the environmental damage caused by pollution can be determined, an environmental charge equal to the cost of damage could be established to serve as a disincentive for environmentally harmful behaviour. By imposing this charge on polluters, the cost of pollution is internalized, automatically encouraging them to reduce pollution to the "optimal" level.

1. Equivalence of taxes and subsidies

Environmental charges are commonly viewed as taxes imposed on the polluter. However, an established monetary value does not necessarily have to be a tax; the same optimal pollution level can be achieved by providing a subsidy to the polluter. In that case, the polluter is paid to curtail pollutant discharges in accordance with the degree of willingness to pay for cleaner surroundings.

The equivalence of an environmental tax and subsidy is an important concept. Intuitively, if pollution has a social welfare cost, society should be willing to pay to stop the polluter from continuing the polluting activity. The net effect is the same as one obtained by imposing a tax on the polluter. The level of the subsidy or tax should be equal to the charge determined by the estimate of environmental damage. If we step back one level from the individual entities (i.e. polluters and society), it is evident that, on balance, whether there is a tax imposed on polluters or a subsidy given to them, the economic resources expended to achieve a given "optimal" amount of pollution reduction are approximately the same.[5]

This equivalence is referred to as Coase's Law and has become of central importance in recent developments, applying economic reasoning to legal issues.[6]

2. The polluter-pays-principle

Another concept gaining credence amongst policy-makers is the polluter-pays-principle (PPP). The convergence of the

1. Regulation continues to be the most suitable for restricting the emission of toxic chemicals and compounds.
2. US EPA, *Environmental Investments: The Costs of a Clean Environment*, Washington, D.C.(December 1990). This estimate excludes activities not directly associated with pollution control or cleanup, such as wildlife conservation and land management. The $ 100 billion estimate covers spending by private business (63%), local governments (22.5%), the Federal government (11%) and state governments (3.5%).
3. Dale Jorgenson and Peter Wilcoxen, "Impact of Environmental Legislation on US Economic Growth, Investment, and Capital Costs", from *US Environmental Policy and Economic Growth: How do we Fare?*, American Council for Capital Formation Center for Policy Research (March 1992), at 8-13.
4. See William J. Baumol and Wallace Oates, *The Theory of Environmental Policy* (Cambridge: Cambridge University Press, 1988), and Tom Tietenberg, *Environmental and Natural Resource Economics*, 2nd ed. (Chicago: Scott Foresman and Company, 1988). Both books have a good textbook treatment of the theory.
5. These costs may differ owing to transaction costs and behavioural inertia on the part of the polluter.
6. R.H. Coase, "The Problem of Social Cost", *The Journal of Law and Economics*, No. 3 (1960), at 7-44.

principle and the use of MBIs leads to a critical policy stance, i.e. the elimination of subsidies for pollution reduction. Economic theory leads us to understand that there is no net economic difference between a tax on pollution and a subsidy to reduce pollution. The PPP favours placing the entire burden of pollution abatement on the polluter. This distinction is only normative, since there will in reality be a partial or full transfer of the burden onto the consumer, depending on the relevant demand elasticities. Thus, an MBI embracing the PPP only eliminates the subsidy option from consideration.

The PPP was accepted by the OECD member countries in the 1985 Declaration on Environment Resources for the Future, in which they undertook to introduce more flexibility, efficiency and cost-effectiveness in pollution control. In particular, they pledged to carry out a consistent application of the PPP and more effective use of economic instruments, in conjunction with the environmental regulations.[7]

The Recommendation on the Implementation of the Polluter-Pays-Principle[8] (adopted in 1974) specifies that member countries, as a general rule, should not assist polluters in bearing the cost of pollution control by granting subsidies or tax advantages. Exceptions to this rule (to be notified through the OECD Secretariat) were allowed only if all of the following conditions were met:

- if they related to industries, areas or plants where severe difficulties would occur,
- if they were limited to well-defined transition periods adapted to the specific socio-economic problems associated with the implementation of a country's environmental programme,
- if they were not likely to create significant distortions in international trade and investment.

Britain adheres most closely to the PPP in the area of industrial pollution control. It is a firm government policy to make industry responsible for the installation and operation of pollution control equipment capable of reducing emissions to the legally acceptable level. If a particular company cannot afford to buy the necessary anti-pollution equipment, the government does not offer subsidies.[9]

In keeping with this policy guideline, Britain has no specific legislation regarding the tax treatment of expenditures related to pollution control equipment. Equipment expenditures are, therefore, subject to the general taxation provisions contained in the current legislation.

C. The advantages of MBIs

To assess the advantages and structure of the MBI incentive approach, it is useful to first examine the more common regulatory approach.

Traditionally, regulatory instruments have been used as the primary mechanisms for translating environmental policy into objectives and results. This approach consists mainly of imposing standards regarding emissions and discharges and product or process characteristics through licensing and monitoring. The basis for this control is some form of legislation or government decree. The polluter's compliance is mandatory and non-compliance sanctions are quite common.

The principal distinguishing feature of a regulatory approach is that it forces all polluters to bear identical shares of the pollution control burden, regardless of their relative costs of control. This is economically inefficient since the actual cost of reducing a unit of pollutant can vary widely based on plant age, process characteristics, etc.

There are two basic types of regulatory instruments – uniform technology standards and uniform performance standards. Technology standards specify the method, and sometimes the equipment, that firms must use to comply with a regulation. Usually, technology standards do not explicitly specify the technology, but instead establish standards on the basis of a particular technology.[10] In one case, all firms in an industry might be required to use the "best available technology" to control water pollution; in a more extreme example, electric utilities may be required to utilize a specific technology, such as electrostatic precipitators, to remove particulates. Performance standards, in contrast, set a uniform control target for each firm while allowing them some latitude in deciding how to meet it. Such a standard might set the maximum allowable units of pollutant per time period, but be neutral with respect to the means by which each firm should reach this goal.

The regulatory (command and control) approach just described is inferior to the economic incentive approach for two main reasons.

Relatively high costs are imposed on society

Technology or performance standards can force some firms to use unduly expensive means of controlling pollution. In a survey of eight empirical studies of air pollution control, it was found that the ratio of actual, aggregate costs of the conventional command-and-control approach to the aggregate costs of least cost benchmark ranged from 1.07 for sulphate emissions in the Los Angeles area to 22.0 for hydrocarbon emissions at all US DuPont plants.[11] The reason for this is that the costs of controlling emissions can vary greatly between, and even within, firms and the right technology in one situation may be wrong in another.

Discourages technological innovation

The regulatory approach tends to gravitate against the development of technologies that could provide greater levels of control. Little or no financial incentive exists for firms to exceed their control targets. (However, it should be noted that both types of standards contain a bias against experimentation with new technologies.) A firm will not be enthusiastic to develop a new control technology that could subsequently be

7. *OECD and the Environment* (Paris: OECD, 1986), at 20.
8. *Id.*, at 27.
9. Secretary of State for Environment and others, *This Common Inheritance*, Common Service 6, No. 1200 (1990), at 271. This publication, known as the White Paper, contains the government's proposals for the next environmental protection bill. Some policies in the Paper, such as the placing of the financial burden of pollution control on industry, restate existing policies.
See also, *The Economist*, 18 August 1990.
10. This section of the paper draws from p. 4 of Stavins and Whitehead (1992).
11. Tietenberg, T.H., *Emissions Trading: An Exercise in Reforming Pollution Policy* (Washington, D.C.: Resources for the Future, 1985).

held as the future standard that it must use or meet, without allowing it any opportunity to benefit from the innovation.

Despite awareness of its disadvantages, the command-and-control approach continues to be used by a number of nations in their approach to environmental protection. The motivations have been discussed extensively by Bohm and Russell.[12] The roots of this anathema towards economic instruments for pollution control is the adversarial attitude that has characterized the beginnings of the environmental movement in many instances. Pollution has often been characterized more as a moral failing of corporate leaders than as a by-product of modern civilization. The characterization, though successful from a political standpoint, has unfortunately resulted in widespread antagonism towards corporations and a suspicion that anything supported by business is probably bad for the environment. In fact, for many years, MBIs were regarded as "licences to pollute".[13] Needless to say, environmental groups frequently apply different and more rigorous standards when measuring market-based systems against their command-and-control options.

Besides the external forces that have resisted the imposition of market-based environmental protection measures, there has been opposition from within the environmental bureaucracy. A number of individuals in these agencies perceive, sometimes correctly, that their work routines, organizational power or even existence, may be threatened by such market-based approaches. For example, market-based policies would not require the service of engineers in the environmental protection administration whose task is to evaluate technologies for disparate sources of emissions across the country. Instead, decisions to select particular technologies to control air pollution would be left up to individual firms. However, the environmental protection administration could provide a valuable service by acting as a clearing-house for information on the capabilities of, and experiences with, various control technologies.

In addition to opposition from the market players, there is also resistance from the firms themselves.[14] Firms seem to prefer regulation because they feel that MBIs would result in costs that may be additional to the existing regulation compliance costs. There is also the implicit feeling that they could have more influence on regulations through negotiations.

Finally, governments may also prefer to be slow in proceeding since there is an element of uncertainty regarding revenues and the inflationary and distributional effects of the various market instruments. Fiscal instruments such as taxes and charges are also politically unpopular in some countries. This is because they are often poorly administered and viewed as being unfair in their application.

1. Principal advantages of MBIs

(a) *Cost-effectiveness*

Compared with most regulatory instruments, economic mechanisms allow a given degree of environmental protection to be achieved at lower cost. This is due to the flexibility inherent to market-based approaches.

To illustrate this advantage, let us consider an example: Assume that it costs source A \$ 500 per ton to reduce emissions and source B \$ 3,000 per ton. Requiring each source to cut back emissions by one ton results at a total cost of \$ 3,500. If, on the other hand, the sources were allowed to trade emissions reductions, source B could pay source A a negotiated amount — say \$ 2,000 — to reduce emissions on its behalf by one ton. As a result, the total cost of reducing emissions would be \$ 1,000, with a cost savings of \$ 2,500. An environmental tax set at an appropriate level would have a similar result.

(b) *Continuing incentive*

Economic instruments provide a continuing incentive for firms to cut back pollution and, therefore, to develop and implement new pollution control technologies and processes. Under regulation, there is generally little incentive for a firm to go beyond required performance standards. This is because:

- Research and development (R&D) into improved pollution control is costly, and its adoption may not lead to direct cost savings.
- Firms may believe that if better technology is discovered, the government will require that it be adopted to achieve higher emission reductions.

(c) *Lower compliance and administrative costs*

MBIs, in some cases, involve lower administrative costs for both governments and industry than would be possible under the regulatory approach. For example, the use of environmental taxes or tradeable permits eliminates the need for government certification of production processes and technologies.

(d) *Accommodates growth and entry of new firms*

Economic instruments can more easily allow for the expansion of existing companies and the entry of new ones into the industry than would be possible with a regulatory approach. While both the regulatory approach and MBI instruments can involve a trade-off between targeted emissions and growth, MBI instruments can be modified more easily to allow growth and entry without greatly increasing pollutant loads.

D. *The measurement problem*

That market-based instruments are theoretically superior to regulatory tools is well established. Nevertheless, despite its many merits, the system of MBIs has not yet been extensively used nor its details fully worked out. The main drawback is the ability of the market or government to set prices for environmental resources. Ideally, charges for destructive uses of the environment, such as the discharge of untreated waste, should be equal to the damage or external cost that these activities generate. In practice, however, it is very difficult to

12. See Bohm P. and Russell C.S., "Alternative Policy Instruments", from *Handbook of Natural Resource Economics*, Kneese A.V., ed. (Amsterdam: North-Holland, 1985).
13. Alm, Alvin L., "The Postregulatory Environmental Protection Regime", *Environmental Science and Technology* 23 (1989), at 1338-1339.
14. See Bohm and Russell, *supra* note 12.

estimate the full extent of environmental damage because it is widespread, often not easily quantifiable, and takes a long time to accumulate.

A more workable system of setting charges is one based on ambient standards. This can be accomplished in two stages. First, technical experts describe the consequences of different levels of ambient quality, for example, human health at different levels of ambient sulphur dioxide. Then, a target level of ambient quality is chosen and a charge for emissions is set at the level necessary to attain this target. The level of the charge for each area necessary for achieving the target level of air or water quality is obtained by estimating the relationship between different charge levels and the emissions from different sources based on the average marginal costs of these sources.[15]

III. ENVIRONMENTAL TAXES, DEPOSIT REFUND SYSTEMS AND TRADEABLE POLLUTION PERMITS

A. *Environmental taxes*

Environmental problems can arise when the market system fails to establish appropriate price signals and incentives in relation to environmental resources. For instance, some of these resources can be used "for free", although their use imposes external costs in the form of water pollution, reduced air quality or other environmental consequences. In some cases, the market price that does prevail covers the private costs of an environmental input, but not the external costs incurred by third parties. When environmental resources are underpriced in this way, producers and consumers are likely to make excessive use of these inputs relative to others that are higher priced. Underpricing also provides insufficient incentives for the development of new technologies to control environmental pollution.

An appropriate environmental tax can compensate for these deficient market signals by raising the price of using environmental inputs to a level that better reflects the total, private and external, economic costs of these resources.

Environmental taxes can be levied on:
- emissions, effluents, or solid waste being released into the environment,
- inputs or materials known to be a source of environmental pressures, and
- final products linked to environmental degradation.

A well-designed environmental tax has great benefits. It confers on producers and consumers the flexibility needed to minimize the costs of achieving a given environmental goal. Faced with an emissions tax, for instance, each firm can compare various ways of reducing emissions and choose the solutions that match its circumstances. The range of possibilities might include changing the product mix, modifying production technologies or installing equipment that can filter or clean the "end-of-pipe" emissions. To the extent that different firms can have different costs for pollution abatement, a charge can encourage firms facing lower abatement costs to go further in cleaning up their operations. In this way, an overall environmental target can be achieved for the whole economy. By comparison, traditional regulations tend to be more costly to the economy, particularly if all firms are required to adopt the same method of pollution control.

Price incentives generated by environmental taxes have long-term consequences. An environmental tax encourages the long-term development and use of "cleaner" processes and products. Regulations offer no comparable incentives for firms to develop and adopt more effective pollution control techniques once the regulatory requirements are met. Moreover, as mentioned earlier, regulated firms may be unwilling to support the development of better abatement technologies.

In some situations, an environmental tax may have advantages over a system of tradeable permits. Taxes raise the cost of pollution while allowing pollution levels to be determined through market mechanisms. A permit, by contrast, sets the level of pollution and leaves the costs (in the form of a market price for permits) to be determined by the market. In the case of an environmental charge, therefore, the polluter knows up front both the costs of investing in pollution abatement and the tax that is payable on continued levels of pollution. In a tradeable permit system, however, the polluter does not have advance knowledge of the price that the market will eventually assign to the permits.

Design issues

The prospects of realizing the potential benefits of environmental taxes depend on the following technical and legal design considerations:
- recognizing the fundamental characteristics of the environmental problem,
- choosing a competent authority to legislate, implement and monitor the tax,
- establishing a suitable tax base, and
- setting an appropriate tax rate.

1. The fundamental characteristics of the environmental problem

For some environmental problems, an environmental tax is unlikely to be an effective solution. For example, in situations where even small amounts of a dangerous substance can seriously damage the environment and human health, regulatory controls would be the preferred instrument. At most, an environmental tax may serve as an incentive for consumers or producers to speed up their adjustments to regulatory requirements.

In general, environmental taxes are best suited to situations where there is a reasonably simple and well-understood relationship between the polluting action and its physical impact on the environment. When the relationship is more complex, the development of effective taxes can pose design problems that may result in impractical tax structures. For example, it is difficult to design a simple tax structure to cover situations

15. Panayotou, T., "Economic Incentives in Environmental Management and their Relevance to Developing Countries", from *Environmental Management in Developing Countries*, Denizhan Erocal, ed. (Paris: OECD 1991), at 98-101.

in which one activity leads to emissions of various pollutants and any measures designed to limit the production of one pollutant can affect the emissions of others. Under such conditions, decisions about what constitutes an appropriate charge on one pollutant must take into account measures planned to reduce other emissions.

In addition, it is important to create a close link between the tax and those decisions that have an important bearing on a given environmental objective. In some situations, the most appropriate tax structure may be a system of charges covering a wide variety of decisions or activities. In other situations, the most promising approach may be to target the environmental tax on a specific problem or area of decision-making that is not being adequately addressed by other measures.

2. Selection of competent authority

The most critical determinant of an effective tax is that a competent authority legislate, implement, monitor and enforce the tax. Although these functions may be conducted by more than one agency, it is necessary that the final authority be vested in a single entity.

The competent authority is required to ensure the following:

- It should facilitate a fair dispute resolution procedure. This is an important way to increase the public acceptability of the tax.
- It should allow for uniform base definitions and rates of taxation across the geographical boundary in question.[16] It is important that the principles on which the environmental tax is based be applied uniformly. Distortions in trade and competition are thereby avoided.
- In instances where a sovereign government has to negotiate internationally about cross-border environmental concerns, applications of countervailing duties on imported goods in cases where the domestically-produced goods bear environmental tax burdens, bilateral tax conventions, etc., it is necessary that a single authority be available to make decisions.

The choice of whether the authority that would bear responsibility for legislating and implementing an environmental tax should be federal, state or municipal is wholly dependent on the existing constitutional division of power, as regards taxation and environmental law, between the federal and local governments. It is not possible to define an ideal authority framework because circumstances vary based on national constitution, size of the nation, existing structure of administrative law, etc. Below is a brief discussion of the division of taxation powers in the United States, which has a federated government structure.

In the United States, for example, water pollution control had been dominated by state regulation until the mid-1960s. By then, however, it was apparent that state regulation was failing to achieve the kind of water pollution control desired by the public. At first, federal intervention was gradual. In the Water Quality Act of 1965, Congress sought simply to oversee state regulation and made no attempt to regulate waste discharges directly. In 1969, the federal government allowed the Corps of Engineers permit system to regulate directly the discharge of wastes into public waters by industries. In 1972, the federal government changed the rules of the game entirely, taking over the responsibility for water pollution control from the states and essentially reversing the federal/state roles. Thereafter, state regulation is allowed only under strict federal supervision.[17]

The courts have supported this expansion of the federal government's role in the environmental law field, as well as other areas of social and economic regulation. They have done so via an increasingly broad interpretation of Article I, Section 8(3) of the federal constitution, the so-called "commerce clause".[18] This clause states that Congress has the power "to regulate commerce with foreign nations, and among the several states...".

This broad interpretation has given the US Congress ample powers to make laws concerning environmental policy. The states also have the legal power to enact effluent charge laws if they choose to do so. However, they traditionally have enacted most of the legislation in the health and environmental fields. Even if a state chooses to enact a particular environmental tax, it would have to ensure that it did not violate the "dormant" commerce clause. This clause ensures that the impact on interstate commerce is not unreasonable, an extremely important consideration since environmental taxes can affect location and production decisions of firms. It is interesting to note that most federal legislation in the environmental field provides that state laws on the same subject are not preempted if they are more strict than the relevant federal act.[19]

At the same time, there are valid arguments for allowing a state more flexibility in determining the level of the charges. In other words, having a federally legislated uniform environmental tax across the entire country may not be optimum. It might be desirable to allow states or local governments to have some flexibility in varying the charge by a certain amount, either above or below the standard set.

3. The tax base

The environmental effectiveness of a tax will depend on whether or not it is possible to define a suitable base for the charge. In this regard, imposing a tax on certain substances, but not on harmful substitutes, would raise questions about the environmental implications, economic costs and fairness of the charge. Moreover, the task of determining what should be included in the tax base is difficult when there are great uncertainties regarding the scientific properties, environmental implications and practical applications of various substances and products. The problem, of course, is not restricted to environmental taxes; it also comes up in relation to regulations, tradeable permits and other instruments.

16. This geographical boundary should effectively encompass the zone of environmental concern. It could be as a small local government jurisdiction or extend across a nation or group of nations (e.g. the EEC).

17. U.S. Public Law 92-500, 86 stat. 880 (codified as amended at 33 U.S.C. Sec. 1342(b)(1982)).

18. See, e.g.,*Wickard v. Filburn*, 317 U.S. 111 (1942); *Perez v. United States*, 402 U.S. 146 (1971).

19. See, e.g., Clean Water Act, 33 U.S.C. Sec. 1370(1982); also, Resources Conservation and Recovery Act of 1976, 42 U.S.C. Secs. 6948, 6947(1982).

Another issue is the administrative difficulty involved in making a clear distinction between what should be subject to the charge and what should be excluded. Experience with the manufacturer-level taxes, such as excises and sales taxes, has shown that these definitions will be tested over time by various businesses and taxpayers. The result of these challenges can shift the definitions in unintended directions unless it is possible to legally defend the distinction.

The base definition issues associated with taxes on input materials and final products are similar to standard sales and excise taxes.

Defining a base for environmental taxes on emissions, effluents or solid waste raises measurement and monitoring issues that are unique. One of the major distinctions in the case of effluent taxes is that substances that have no intrinsic value are being taxed. These substances leave no traces of recorded monetary transactions and provide no incentive for storage. Further, physical constraints eliminate the storage option. For example, it is virtually impossible to store air pollutant emissions for periodic stock measurement nor is it practical to have firms store effluents in specially built containers. Consequently, measurement needs to be conducted on a flow basis. More importantly, there is only a single time and event (taxable transaction) that can be used for determining the tax. In this case, it is the moment the effluent or air polluting emission is discharged.

In the case of environmental taxes on input materials or final products, there are a number of potential taxable events. Goods can be taxed when manufactured or sold. Here again, there are options as to the sale amount at which the tax may be imposed. Although some potential transactions are more favourable from the standpoint of administrative ease, the presence of others allows for audit checks or verification.

Measurement often poses a problem in the case of effluent taxes. Most finished goods and inputs have well-defined standards and tools for measurement. Effluents and emissions are more difficult to define because it is not the simple volume of discharge that is important, but rather the constituent pollutants that are present in the discharge. Effluent tax base definition must, therefore, include an explicit set of measurement procedures and standards to ensure uniformity and fairness in tax application.[20] This is both to avoid having to constantly deal with disputes that could arise, as well as to provide an objective legal basis for resolving disputes that do arise.

Two examples of base definitions in existing environmental taxes are considered below:

- effluent charge base definition in Germany, and
- excise tax base on ozone-depleting chemicals definition in the United States.

(a) *The definition of the effluent charge base in Germany*

The German Effluent Charge Law (ECL) provides the states (i.e. "Lander") with the power to levy charges on direct discharges into public waters of specified effluents.[21] Firms and households discharging into municipal sewage facilities are not charged directly.[22]

The German example has shown that for a charge to be successful, it should be restricted to a limited number of readily identifiable effluents. The ECL contains all the data needed to calculate the waste water discharge bill or tax. The pollutants considered for purposes of effluent charges are settleable solids, chemical oxygen demand, cadmium, mercury and toxicity for fish. In the first step of base definition, the ECL establishes the discharge right and includes all the physical, chemical and biological data and monitoring procedures pertaining to waste water quality.[23] This part of the law also serves to establish the measurement procedures in case of a dispute.

For each firm, the state also specifies a total discharge, based on historical volumes, of waste water allowable per year. Since the effluent charge is combined with a permit procedure, maximum effluent levels are also specified. The actual effluent discharged by the firm must be of a quality equal to or higher than the minimum requirements laid out in the administrative regulation. The taxable base is specified in terms of concentration per cubic metre of discharge volume or per ton of product produced.[24] A firm's discharge is then converted into damage units using coefficients provided in the law. The tax liability is determined by multiplying the number of damage units by the tax rate per damage unit. This tax rate is revised annually based on an established increment.[25] To provide an incentive to limit one's pollution load, higher charges are imposed per damage unit if firms exceed the permit limit. These excesses are allowed only twice a year. Lower charges per damage unit are used to compute the total tax liability for those who discharge below permit limits.

(b) *Definition of excise tax base for ozone-depleting chemicals*

Following the signing of the Montreal Protocol on Substances that Deplete the Ozone Layer, provisions aimed at reducing the use of such chemicals were included in the US Revenue Reconciliation Act of 1989.[26]

The above provisions impose an excise tax on ozone-depleting chemicals (ODCs) sold or used by manufacturers, producers or importers of these chemicals or by the importers of any products manufactured using ODCs. The tax is the product of the chemical's weight (in pounds) times the base rate

20. To illustrate the problem with measurement, take the example of sulphur dioxide in air pollutant emissions. The reading taken by the same instrument placed in a chimney can change based on its distance from the inner wall of the chimney. The readings can also be affected by the orientation of the device to the direction of gas flow. Clearly this does not make an emission tax a simple tax to monitor.
21. Abwasserabgabengesetz (1976), i.e. Effluent Charge Law (ECL) Art. 3(1).
22. For a more detailed discussion of the ECL, see Gardner Brown Jr. and Ralph Johnson, "Pollution Control by Effluent Charges: It Works in the Federal Republic of Germany, Why not in the U.S.", *Natural Resources Journal*, Vol. 24 (October 1984).
23. ECL Art. 4(4).
24. For example, chemical oxygen demand (COD), mercury and cadmium discharges are based on production volumes, whereas settlelable solids and toxicity towards fish are based per unit of wastewater discharged.
25. ECL Art. 9(4).
26. Secs. 4681 and 4682 of the Revenue Reconciliation Act 1989, effective 1 January 1990, outline the taxation of the sale and use of such ozone-depleting substances. The IRS has provided guidance for implementing the excise tax on ozone-depleting chemicals (ODCs) in Notice 90-8, IRB 1990-5, 14, and Notice 90-9, IRB 1990-5, 21.

times the ozone depletion factor for the chemical. The ozone depletion factor for each chemical is fixed and specified in the law and the base tax rate is revised as required. The tax is imposed at the time the manufacturer or importer sells or uses the ODC.

The above definition of the base is fairly simple and is easily applied when the ODCs are used in a virgin state. However, complexities arise whenever (i) an ODC has been used in the manufacture of an imported product because determining a reasonably accurate countervailing tax would require detailed information on the actual manufacturing process employed, or some other means of calculating a presumptive levy based on similar products manufactured domestically, and (ii) the ODC is a feedstock in a process where it is totally consumed or transformed so that there is no ozone-depleting effect. In this case, the issue is whether or not an exemption should be granted.

4. The tax rate

Setting an appropriate rate for the environmental tax can be a difficult operation. Ideally, the rate should raise the costs of using an environmental resource so that it reflects costs imposed on third parties. As discussed, however, this approach rests on the unrealistic assumption that one can identify and assign monetary values to all the externalities linked to the use of an environmental input. A next-best approach is to set the rate according to a predetermined target for the environment and the anticipated response to various changes in price signals.

In selecting a tax rate, it is also important to distinguish between long-term and short-term objectives and responses. In general, the long-term response to a given tax rate is likely to be larger because it will include the changes in capital stock and durable goods that can benefit the environment. This suggests that an environmental tax that sets out to encourage changes in patterns of production or consumption over a number of years can be effective at a lower rate than one intended to achieve major results in the first year or two.

(a) *Environmental taxes on emissions, effluents or solid waste*

Environmental taxes can be imposed on airborne emissions, water effluents or solid waste at the point of release into the environment. This is the most direct way to apply a charge on harmful pollutants or waste materials. One example of this type of approach would be a tax on the emissions of common industrial air pollutants, such as sulphur dioxide (SO_2). For the management of water resources, an environmental tax could be levied on the discharge of certain chemicals, suspended solids and other substances into rivers, lakes and other bodies of water.

This type of environmental tax can achieve a close link between the amounts payable under the tax and under the environmental resource. For producers, the tax would cause an increase in costs at each level of production. Under normal conditions of supply and demand, the charge paid by producers would also move through the price system to product markets. As a result, the prices of final products would better reflect environmental costs and consumers would be encouraged to switch to products that were less harmful to the environment.

This approach has the additional advantage of allowing producers complete flexibility in choosing the most cost-effective method of reducing their discharges, whether over the short-term or over longer planning horizons. Therefore, any changes they make to their equipment or production patterns in order to reduce the pollutants in question can reduce their payments of the charge.

International experience with these taxes has shown them to be of limited use in the development of effective incentive-oriented charges. The country with the most experience with emission taxes is France and studies have shown that the rates were set too low to provide much of an incentive for improving environmental decision-making.[27] It was found that to have the desired effects, their levels would in most cases have to be quadruple the current levels.

Germany has been using a system of effluent taxes that combines a basic regulatory approach with an environmental tax. Producers who meet certain pollution reduction standards are permitted to pay a lower rate of charge on their emissions. Those who do not meet the standards for their sector are required to pay the full amount of the charge on all of their discharges.[28]

Administratively, higher rates are found to require complex tax structures and administrative mechanisms. Low rates enable governments to adopt simple estimating procedures for applying the taxes. Taxes based on actual discharges are considered to involve higher costs of administration and enforcement. The issue of enforcement is crucial since a heavy charge on the disposal of certain substances or materials generates an incentive for polluters to look for ways to avoid paying the charge. Some of these responses can be environmentally damaging, as is the case with illegal dumping. When this practice involves hazardous wastes, the environmental costs of this form of cheating can be heavy. Controlling these types of environmentally damaging behaviour can require costly enforcement measures that go beyond the administrative procedures of existing tax systems.

One of the possible ways of reducing the costs of administration and enforcement is to apply the environmental tax on inputs or products, rather than on emissions or effluents.

(b) *Environmental taxes on inputs or materials*

Where taxes on effluents or emissions pose major problems for design or implementation, a charge levied at an earlier stage in the pollution cycle may be the preferable approach. In some situations, it may be more practical to impose the charge on certain inputs or materials. This type of charge may be set according to the input's potential to generate emissions, effluents or solid waste. If some inputs to production processes are more damaging than others, it may be possible to develop a set of tax rates that recognizes these differences. For example, leaded gasoline may be taxed at a higher rate

27. D. Olivry, *OECD Case study for France*, ENV/ECO/86.10.
28. *Supra* note 22, at 929-966.

than unleaded gasoline because it is environmentally more damaging.

Environmental taxes on inputs have three important advantages:

- They do not require the monitoring of the levels of emissions, effluents or waste leaving each source of pollution. This means that the costs of implementing and administering an input tax can be smaller than that for an emissions or effluent tax. For example, excise taxes imposed on motor fuels at the refinery gate are administratively simple. These taxes also provide some price incentive to conserve fuels and, therefore, reduce vehicle exhaust emissions.
- Since an excise tax on pollution-generating inputs can be collected directly from the producers of these inputs, it is likely that the number of taxpayers will be considerably less than in the case of an effluent tax.
- By changing the relative prices of various inputs, this approach can encourage firms to use the taxed input more efficiently and to switch to untaxed inputs that are better for the environment. Over the long term, the charge can continue to encourage firms to change their input mix and to invest in the development of environmentally preferable inputs and more efficient technologies.

The United States and Denmark have imposed taxes on chloro-fluoro carbons (CFCs), which are ozone-depleting chemicals used as refrigerants for cooling applications and also as solvents in the production of semiconductors. These taxes have been difficult to administer because they also raise complex issues, such as determining the treatment that should be accorded to imported products containing CFCs. Strictly, these imports should also be taxed to avoid giving imported goods a competitive advantage. However, applying a suitable charge to each of these products can be a difficult task if the technical information on the manufacturing process employed is not available.

It may also be difficult to apply an input tax when some inputs or uses are much less damaging than others. Under these circumstances, the most appropriate tax structure would be one with differentiated tax rates. In practice, however, there may have to be some trade-offs the various mechanisms that can be technically designed into the structure of the charge in order to achieve a given environmental target.

(c) *Environmental taxes on final products*

Environmental taxes on final products are best used to combat environmental problems closely linked to consumer demand for certain products or commodities. A tax on final products raises the tax-inclusive price so as to better reflect the total costs associated with the production, consumption and/or disposal of the product.

Examples of this approach would include imposing a tax on certain commodities that add to the flow of solid waste, such as disposable products that compete with reusable alternatives.

One of the significant benefits of a well-designed product charge is the direct relationship it has to the preferences and choices of the consumer. Product taxes increase consumer awareness of the environmental implications associated with the use of a particular product or commodity. Product taxes also allow flexibility in consumer response. Some may prefer to conserve or reuse existing supplies, while others may shift to alternative products that are better for the environment.

Compared to other types of environmental taxes, a final product tax may be more easily adapted to address concerns about international competitiveness. If a tax is imposed on a final product, it can easily be accompanied by a corresponding duty on imports and an exemption for exports. This can be done without the complex tax structures needed to achieve similar results through emissions or input taxes.

B. *Deposit refund systems*

Deposit refund systems link special front-end charges or deposits, which are refundable when quantities of the substance in question are turned in for recycling or proper disposal. These schemes are intended to achieve some or all of the following objectives:

- protect public health and welfare,
- encourage recycling,
- reduce the burden on solid waste disposal systems, and
- reduce litter.

A common example of the deposit refund system is the one used for beverage containers in the United States. The refund provides the consumer with the incentive to seek proper disposal of containers, i.e. bottles and/or cans. Since 1971, most states in the United States have at least considered some form of a deposit refund bill on bottles and cans, while nine states have succeeded in enacting such a bill.[29] There have also been efforts to establish a nationwide programme requiring mandatory deposits.

Deposit refund programmes have been proposed for a variety of materials, including vehicle tires and car bodies. The strongest case is made, however, for products with very high costs of improper disposal, e.g. lead acid batteries, industrial solvents and used lubricating oils. In these instances, the toxicity of the waste is of particular concern. Waste-end fees such as user charges for garbage disposal are not totally appropriate because these materials require special handling. Further, raising these waste-end fees to cover the costs of disposal can increase the likelihood of illegal dumping of these substances. The ecological consequences of such illegal dumping, especially due to their toxicity and associated clean-up problems, can be substantial. Input taxes, as discussed in the earlier section, may provide incentives to use less of the substance or encourage the search for cheaper substitutes, but will not solve the problem of improper disposal or illegal dumping. Deposit refund systems, therefore, represent a cost-effective way to manage these categories of toxic wastes and other hard-to-dispose objects like car bodies and tires.

Deposit refund schemes can be structured to handle a variety of substances or consumer goods, including beverage containers, e.g. bottles and cans, lead acid batteries, used lubricating oils and other industrial chemicals. In each of the above cases,

29. The states are Vermont, Maine, Massachusetts, Connecticut, Delaware, New York, Michigan, Iowa and Oregon.

the cost-efficiency and design issues often differ due to implicit public policy concerns or objectives, as well as the physical peculiarities of the substance itself. We will thus deal with each of the above cases in turn in order to address the design methods of a workable deposit refund scheme.

1. Beverage containers

Deposit refund schemes for beverage containers have been used as measures to control litter and encourage recycling.

Typical deposit refund legislation for beverage containers would need to address the following design aspects:

- The need for a definition of the term "beverage" that would often explicitly exclude dairy products, natural fruit juices, wine and other alcoholic beverages except beer.[30]
- The law could also prohibit the sale of such beverages in disposable containers. A disposable container may be defined as one not intended or designed for return or reuse. Alternatively, a higher tax could be imposed on disposable containers. Unfortunately, this would mean higher administrative costs.
- A refund value that would be added to the price of the beverage should be established. Consumers who purchased the beverage containers would thus pay the price of the refund value, in addition to the standard sale price.

  The refund value can be of either a single or multiple-tier type. A single-tier refund sets a single refund value for all containers. A multiple-tier refund would distinguish containers based on certain characteristics and establish differential refund values. For example, (i) containers made of particularly desirable raw materials could bear lower deposit values, while all others would require a higher mandatory deposit, and (ii) containers reusable by more than one beverage producer could also be eligible for a lower deposit.

  The administrative complexity of a system would increase in direct proportion to the number of such differentiated rate schedules. However, the differentiated rate structure ideally provides environmentally more appropriate incentives.
- A scheme for the redemption of the deposit on containers that are returned should be defined. Usually, dealers[31] and certified redemption centres would be required to receive empty containers and refund deposits.

  The redemption scheme may be varied to suit the particular circumstances and needs of the retailing sector. Issues to be considered include:
  - whether dealers should accept only beverage containers of the "kind, size and brand" sold, or whether they should be required to accept all containers carrying deposits;
  - whether dealers should be compensated, by means of a handling fee, for their effort, cost of storage, etc.;[32]
  - whether dealers should be allowed to refuse beverage containers that are not clean when returned, (and if so, what should the appropriate standards of "reasonable" cleanliness be).
- Standards for container labelling should be set. The labelling requirements depend largely on the type of deposit-refund structure, i.e. the number of tiers, etc.
- Penalties that may be imposed on manufacturers and dealers who do not follow the requirements laid out in the deposit refund law need to be established.
- Responsibility for the implementation, monitoring and enforcement of the programme should be given either to a single bureau or to a group of public agencies.

There are many arguments both for and against deposit refund schemes for beverage containers. For each argument, there have been a substantial number of counterarguments, which to some extent explains why such schemes have been legislated in only nine US states. The arguments are often based on volumes of statistics advanced by both the proponents and opponents. These statistics are, understandably, contradictory and any public policy decision will have to take into consideration the specific circumstances in each nation. The following discussion draws on some of the arguments that have been used in the United States.

Litter Control: Deposit-refund systems have been fairly effective in curbing litter in public places and other locations. In a number of US cities, the litter from beverage containers has been substantial, with volumes of up to 60 to 70 percent of the total. The deposit refund systems have reduced litter volumes by 30 to 61 percent in states that have adopted such schemes. The reduction in beverage container litter alone ranges from 75 to 85 percent.[33] In New York, litter control costs have been reduced by $ 50 million since the deposit refund bill was passed, while in Maine, cleanup costs have been cut in half since the deposit law took effect.

Solid Waste Reduction: Solid waste disposal has in recent years been faced with the combined problems of high-cost and the lack of available landfill space. The argument that deposit refund schemes reduce solid waste and, therefore, provide indirect cost savings has, however, not been very credible. Beverage containers form only a small percentage of total solid waste volume. In the United States, bottles and cans account for no more than five percent of the total solid waste volume. Thus, a national deposit refund system may decrease total solid waste volume by no more than two percent.[34] Thus, although a deposit law may reduce solid wastes to a greater or lesser extent, based on national consumer profiles, the issue concerns whether or not the reduction in itself warrants the adoption of a programme that will force the beverage industry to modify the way it produces, distributes and sells beverage containers.

30. Senate Bill 38, Sec. 10-213.4, Virginia General Assembly, United States.
31. Persons engaged in the sale of beverages and beverage containers to consumers.
32. Most states in the United States with mandatory deposit refund schemes have instituted a handling fee equal to 20% of the value of the deposit.
33. Environmental Action Foundation, Briefing Papers: Litter Reduction 2, as quoted in Weinberg (1987).
34. See Perry Weinberg, "Mandatory Deposit Legislation in Virginia: Recycling the Bottle Bill", *Virginia Journal of Natural Resources Law*, Vol. 7 (1987), at 194.

Energy Conservation: Before examining this argument in greater detail, it is useful to draw a distinction between reuse and recycling. Recycling is a general term that does not always imply the reuse or refilling of the same container. Deposit refund systems always encourage recycling, but their effect on energy conservation may depend on the form of recycling.

In the case of aluminum or steel beverage cans, the cans are always melted down and the metal recycled. Recycling aluminum cans in this manner saves 95 percent of the energy required to manufacture them from raw materials.

However, in the case of glass bottles, the level of energy conserved (or the incremental energy expended) can depend on whether the bottles are crushed for remelting or refilled. It has been argued that refillable bottles may actually result in more net energy consumption than crushing the glass and recycling them since the sanitization process for refillable containers requires water that needs to be heated, thus increasing energy consumption.[35] It is also argued that shifting to refillable bottles will increase transportation costs.

The above point is made only to show that the concern over the level of energy conservation should not be central in influencing the decision to introduce a deposit refund law. More substantively, the energy conservation debate can be used to consider policy choices between making the use of refillable bottles mandatory versus allowing the decision to be made privately in the market.

2. Lead acid batteries

Lead acid batteries are often improperly disposed of in some of the wealthy industrialized countries. Most of the lead which enters landfills and incinerators in the United States comes from storage batteries.[36] Although a substantial amount of lead from motor-vehicle batteries is recycled in the US each year, the share of batteries recycled has been decreasing during the last 30 years.[37]

A deposit refund system for lead acid batteries is attractive primarily because it encourages the safe disposal of lead acid batteries. More specifically, it prevents lead from being leached from unlined landfills or being emitted into the atmosphere from incinerators. Encouraging the recycling of lead from batteries is a possible secondary objective.

Under a deposit refund system, a deposit would be collected as a tax when manufacturers sold batteries to distributors, retailers or original equipment manufacturers. Retailers would collect their deposits by returning their used batteries to redemption centres, which would, in turn, redeem their deposits from the administering agency. The deposit must be large enough to encourage a substantial level of return, but small enough to avoid a significant theft problem.

A similar deposit refund scheme may be used for car bodies, rubber tires and objects such as refrigerator shells. In all these cases, the toxic nature of the object is not of concern as much as the litter and solid waste problem. The unpleasing sight of rusting car hulks in open public spaces is probably familiar to most people. This gets to be a problem because individuals in many countries have to pay to have automobiles disposed. However, if the price of the car included a deposit that would be collected as a tax and refunded at the time of disposal, at specifically designated facilities, there would be a strong incentive to claim the refund at the end of the automobile's useful life.

3. Used lubricating oils

The improper disposal of lubricating oil has both health and ecological consequences. The most serious problems occur when it is dumped into storm sewers or placed in unsecured landfills, contaminating ground and surface water supplies. To a lesser extent, it causes air pollution when burned as fuel.

The two principal sources of used oil are the industrial sector and the automotive sector. A large share of the used oil generated by the industrial sector is reused internally, for example, as fuel in industrial generators and boilers, or collected for reprocessing or recycling.

The automotive sector includes service stations, oil change outlets, the farm/rural sector and independent small transport companies. Some of the used oil generated by this sector, particularly by the larger commercial operations, is now collected for reprocessing or recycling, although a much larger share could be recovered from commercial automotive sources. Most of the oil generated by the oil change outlets, the farm sector and small transport companies is inappropriately discarded. Even if these disposal practices were made illegal, the possibility of being caught and fined is very low.

There is a market for some of these used lubricating oils and some enterprises offer centrifuging and re-refining facilities to remove impurities. In some cases, the oil, while unsuitable for its original use, can be utilized as a fuel. In cases where the reprocessed oil can be used for its original purpose, the economic benefit is greater. Unfortunately, in most countries, these reprocessing facilities are readily available only in some of the bigger industrial or urban areas. In addition, the collection of these oils is often restricted to the larger industrial sector, which, as pointed out earlier, is not the principle source of improper disposal.

A deposit refund system for used lubricating oils should focus on the smaller sectors. The simplest version of such a programme would require consumers to pay a deposit to retailers for each quart of oil purchased. They could then receive a refund when they returned the used oil to redemption centres. The programme design should ensure that the existing enterprises engaged in the collection of used oils from the large industrial and commercial service sector are not affected.

Two options are available for the structure of deposit refund schemes for used oils. Collection depots for used oils could

35. National Soft Drink Association, *Forced Deposit Laws ... There are no Winners*, USA (1985).
36. See Stavins and Whitehead (1992), at 28.
37. In 1955, the recovery rate of used motor-vehicle batteries was over 90%; by 1988, it was approximately 75%. Annual fluctuations around this trend, however, have been substantial and are closely linked to prices of virgin and refined lead. See Putnam, Hayes and Bartlett, Inc. *The Impacts of Lead Industry Economics on Battery Recycling* (Cambridge, Massachusetts; June 1986), Report to the Office of Policy Analysis, US EPA.

be established in local communities or existing service stations and other commercial businesses could be used as collection points.

Under the first option, where special local depots would be established, efforts must be made to ensure that they are individually able to accumulate used oils in quantities large enough to be serviced by the oil reprocessing facilities. The depots could also serve as collection points for other products. This would reduce the fixed-cost distribution for all products involved, while at the same time increasing convenience for consumers and making collection potentially more successful for all products.

Under the second option, collection depots could be established at existing service stations and other small lubrication operations. Some of these outlets may already have a contract with a collection service and, therefore, they may be equipped with the necessary holding facilities. For others, the facilities would have to be built. The advantage of using an existing facility, such as a service station, is that people would find it more convenient to use it, thereby generating a higher recovery rate. On the other hand, however, such service stations might be discouraged from participation for fear of receiving oil contaminated with counterfeit substances.[38] In general, difficulties associated with detecting adulterating substances would pose a serious problem for the deposit refund system for lubricating oil.

Similar schemes may be designed to encourage the safe disposal of industrial solvents and other toxic chemicals. It is necessary to ensure in all these cases that the deposit be large enough to serve as an incentive to bring the solvent to the collection centre for disposal.

C. *Tradeable pollution permits*

Under this approach, the responsible regulatory authority sets a ceiling on total allowable emissions of a pollutant. It then allocates the allowable emissions total among the sources of the pollutant. It does this by issuing permits which authorize plants or other sources to emit a stipulated amount of the pollutant over a specified period of time. Permits can be bought and sold; hence the name "tradeable permits".

Tradeable permits have been used in the United States for lead-permit trading among refiners during the phase-out of leaded gasolines. Under this system, refiners were allowed to trade lead reduction credits. These credits were generated when refiners reduced the lead in gasoline by more than the amount required under the regulatory programme. A trading programme is used for reducing water pollution in the Fox River in Wisconsin.

In 1988, a system of fully tradeable CFC production permits was introduced by the United States as part of its programme to phase out CFCs. Permits were issued to producers and importers in proportion to their 1986 production or import levels. Under this system, the number of permits declines over time in step with the phase-out schedule. There are no restrictions on the use of CFCs produced within the permit limit.

In the most ambitious trading programme undertaken so far, the 1990 amendments to the US Clean Air Act established a comprehensive tradeable permits system for SO_2 emissions from electric utilities. The first phase of the programme, which begins in 1995, targets the power plants with the highest rates of SO_2 emissions. In 2000, the number of permits or allowances will be reduced, and the programme will be extended to all power plants.

Tradeable permits offer a number of advantages:

(a) there is a high degree of confidence that pollution control targets can be met,
(b) the scheme is flexible enough to accommodate growth in the industry without compromising environmental quality, and
(c) since the scheme deals with quantities (i.e. total pollution loads) rather than prices, it is insensitive to inflation. In contrast, environmental taxes, which are normally specific, need to be regularly indexed to inflation.

The scheme also has a number of limitations. In order to realize the full benefit potential of tradeable permits, it is important that the permits be made freely tradeable within individual industry groups and between industries. Usually, some restrictions are necessary to prevent abuse. However, the success of the tradeable permit programme depends critically on the number of sources available for potential trades. The greater the number of sources targeted by the permit programme, the greater the likelihood of free competitive trading.

To achieve competitive trading, the following design issues are important:

1. Definition of the trading area or zone

A trading area or zone is the geographical area within which sources of a given pollutant would be allowed to buy and sell permits.

From the perspective of environmental protection, the ideal trading zone is one that encompasses an area throughout which emissions can be traded without exacerbating the environmental problem in any one portion of the area. Thus, the definition will depend upon the extent of environmental impact, i.e. whether it is localized or more widespread. Ideally, each zone should cover an area in which the environmental problem is similar.

Another factor in the definition of trading zones is the amount of emission per zone. In order to realize all the potential cost savings from emissions trading, there must be a sufficient number of sources in each trading zone to create an active market in the buying and selling of permits.

Related design issues concern the mediation of trading between zones.

2. Seasonal and episodic controls

Some environmental problems vary greatly by season. For example, ground-level ozone is mainly a summer problem

38. Robert Anderson, Lisa Hofmann and Michael Rusin, *The Use of Economic Incentive Mechanisms in Environmental Management*, Research Paper No. 051 (Washington, D.C.: American Petroleum Institute, June 1990).

and, environmentally speaking, it would be undesirable to allow trading which would increase emissions in the summer months.

One way in which seasonal environmental problems could be addressed within a trading programme would be to issue permits exclusively in the season in which the problem arises. Alternatively, separate permits could be issued for other times of the year in which the problem is less severe. A third option would be to issue separate permits, but to allow their trading if it would result in emissions being reduced during the season with more severe environmental problems.

In addition to seasonal variations in emissions, in the case of certain environmental problems, there may be episodes in which the concentration of a pollutant is particularly high. Weather conditions, for example, can lead to episodes of high concentrations of ozone during the summer months. It may be desirable to incorporate the possibility of implementing supplementary controls in the trading system that could deal with such short-lived or episodic problems.

3. Initial allocation of permits

When a trading programme is first launched, the total number of permits must be allocated among the sources of pollution included in the programme. Two options for the initial distribution are worth considering. One is to allocate the permits to existing emission sources based on historical emissions. In this case, the ultimate distribution of the permits would be determined by the market as licence holders buy and sell their permits. The other option is to hold an auction, in effect leaving the distribution to the market right from the start of the programme.

Distribution on a historical basis requires choosing a period to serve as the basis for the initial allocations. The period should be recent enough for the allocations to be consistent with current output levels, thereby enabling firms to carry on their business. It should not, however, be so recent that firms could have knowingly increased their emissions in order to increase their initial allocation. The period could be a several year average. This would compensate for temporary fluctuations in emissions caused by business cycles and shut-downs. In finalizing initial allocations based on the historical period, adjustments should be made to take into account any prior emission reduction actions taken by firms, in order not to penalize those that have already restricted emissions.

An auction would require the sources of pollution to pay for permits. The market would, in effect, determine the initial distribution among the firms. This would relieve the regulatory authority of the necessity of determining the number of permits to issue to each source according to the type of procedure discussed above.

From the standpoint of realizing the potential economic benefits of a trading programme, there is little difference between the two options. Auctioning, however, may encourage the potential benefits to be realized sooner. For example, auctioning, if announced well in advance, can encourage corporations to compare the expected costs of purchasing permits with the costs of investments in pollution abatement. It is true that these cost comparisons and the appropriate investments would eventually be undertaken under a functioning trading market regardless of the initial means of distribution. Nevertheless, under an auctioning system, these results might be realized sooner.

Auctioning can, however, create a set of market structure problems that must not be ignored:

- If the permit market is dominated by a small number of large firms which compete with smaller firms in the product market, the large firms could seek to bid up the price of permits as a means of driving their weaker competitors out of business. Distribution on the basis of historical emissions might be preferable to an auction in such cases of market power.
- Auctioning creates more uncertainty for the sources of pollution than allocation based on historical emissions. Auctioning is likely, therefore, to be less acceptable to industry.

It is interesting to note, however, that the method of initial allocation of permits does not affect the congruity between a tradeable permits system and the polluter pays principle. Irrespective of how the permits are distributed, the polluter bears the cost of cutting back emissions.

The initial allocation of permits will also determine the tax treatment from the perspective of both buyer and seller. If the permits are auctioned, it is very easy to determine the cost basis of the permit. However, if the permits are distributed based on historical emission records, the cost basis is more difficult to determine, and in most cases may be taken to be zero, with subsequent sales being taxed as either capital gain or operating income based on the sales realization.

The depreciation treatment of pollution permits is dependent on the life of the permit. These issues will depend on seasonality, permit banking, etc. The United States, which has the most experience with pollution permits, has not resolved these issues completely, and it stands as one of the main drawbacks to trading.

4. Monitoring and enforcement

Once established, a trading programme would require two types of monitoring. These are (i) the monitoring of emissions, as required under any regulatory programme, and (ii) the monitoring of trades. Under current regulations in most countries, large-scale sources of pollution — which are the kind most likely to be included in a tradeable permits programme — are often responsible for monitoring and reporting emissions on a regular basis. This would continue under a trading programme as well. Additionally, these sources should be required to report any trades.

The integrity of the system would require the establishment and enforcement of penalties for exceeding the emission levels allowed by permits. The penalties should be high enough to be an effective deterrent to wilful violations over an extended period, but not so high as to impose an unfair burden on companies that produce excess emissions in a given period for reasons beyond their control.

Strict penalties on excess emissions could be balanced by measures to ensure that permits would be available for purchase in case of emergency.

5. Potential barriers to trading

For the potential economic benefits of an emissions trading programme to be fully realized, it is essential that well-functioning permit markets develop. There are three types of barriers to trading that could inhibit the development of an active market in permits:

- high transaction costs created by cumbersome and/or unclear trading rules established by the regulatory authority,
- the inability of willing buyers and sellers to identify one another, and
- the hoarding of permits.

To ensure the integrity of the system, the trading rules would have to allow for the effective monitoring of emissions and trades. However, they should not create transaction costs so high as to discourage willing buyers and sellers from trading. For example, requiring prior approval of trades would make exchange cumbersome and inhibit trading. In addition, prior approval of trades does not necessarily ensure the integrity of the programme.

There are two possible ways to ensure that potential buyers and sellers of permits would be able to find each other. The regulatory authority could publish a regular list of permit holders, identifying those that have permits to sell and those interested in buying. Alternatively, this function could be undertaken by private sector firms that could also act as brokers.

Firms that are unsure of acquiring permits on the market at a later date may be inclined to hoard surplus permits to meet future needs. They may also be inclined to hoard permits as a means of gaining an advantage over competitors. To some extent, permit markets are self-regulating against this tendency; the more permits are withheld from the market, the greater their price will be, and the greater the implicit cost of withholding. Firms would also be less inclined to hoard permits if the permits were frequently reissued. The possibility of hoarding would be avoided if permits could not be carried over from one period to the next, although it may be desirable to allow permits to be carried over into subsequent periods. The regulatory authority could promote active trading, and thus reduce the incentive to hoard, by holding back a certain number of permits and auctioning them off at intervals.

6. Banking of permits

The banking of permits would allow a company to save unused permits from one period, carry them over and apply them to emissions in a later period.

As pointed out earlier, this could inhibit permit trading, as firms might be inclined to accumulate excess permits for future use. However, banking does offer certain advantages. It prevents instability which might occur in the price of permits near the end of a trading period as permit holders attempt to unload any excess permits before they expire. More importantly, banking can accommodate businesses that experience pronounced business cycles, and can give firms more flexibility in meeting emission reduction targets or in phasing out polluting substances.

Banking can provide other advantages when the programme calls for a progressive reduction, over time, in the number of permits allocated. In such cases, it can provide an incentive to firms to invest in pollution control earlier, rather than later, and thus accumulate surplus permits to sell at what is likely to be a higher price.

IV. CONCLUSION

From this analysis of MBIs for the control of pollution, it is clear that no single instrument will be sufficient. The nature of the environmental damage and its causes will usually dictate which class of market interventions will be politically and administratively most effective. There remains a critical need for innovations to be initiated in this area of public policy. Such innovations are needed not only in the administrative, monitoring and compliance areas, but in the design aspects of such MBIs as well.

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