Green Taxes and Incentive Policies

An International Perspective

Glenn Jenkins and Ranjit Lamech

A Copublication of the International Center for Economic Growth and the Harvard Institute for International Development

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Copublishers' Preface

ICEG and HIID are pleased to publish jointly this volume by Glenn Jenkins and Ranjit Lamech as the eleventh in ICEG's series of Sector Studies. Sector Studies either analyze one country's response to a specific policy problem or compare the policies of several countries. This sector study examines alternative mechanisms for protecting the environment.

Improving the environment is an objective widely shared by producers and consumers in rich countries and in poor ones. While there is a consensus among disparate groups that something needs to be done to reduce the pollution of our air and water, there is no consensus about how to achieve this goal. Some advocate a regulatory approach with stiff penalties applied to all who violate some legally established standard of pollution. Others argue that market-based incentives that allow polluters choice in how to achieve reductions in damage to the environment are not only easier on the polluters, they also are usually more effective in reducing the overall level of damage and doing so at a lower cost to both the producers and society.

This study by Glenn Jenkins and Ranjit Lamech comes down clearly on the side of market-based incentives. The regulatory approach may appeal more to confrontation-minded advocates and to the government officials and lawyers who will manage the regulatory process, but that approach wastes resources by distorting economic choices. Through market-based approaches, it is possible to take into account the varying circumstances facing different polluters of the environment. Compliance, to a substantial degree, can also be made voluntary because the incentives will either make it financially rewarding to use environment-friendly technologies or financially costly not to do so.

Designing effective market-based incentives requires in-depth knowledge of the alternative kinds of taxes and subsidies available and how firms and individuals are likely to respond to them. To that task, Glenn Jenkins and Ranjit Lamech bring a wealth of experience. HIID, together with Harvard's International Tax Program, which HIID helps to run, has been involved in reforming tax systems around the world over nearly two decades. In more recent years, work on the environment, which had been done on an ad hoc basis, has become a major focus of both HIID's research program and of its overseas advising activities. This study brings these two strands of HIID's work together in one place. The focus of the volume is on the experience of advanced industrial economies, for the most part, because that is where much of the experience with market-based environmental incentives resides. The lessons learned, however, with some adjustment for differing circumstances, can be readily applied to the increasingly severe environmental problems of the developing world as well. ICEG has a long-standing interest in the environment, having published several major environmental studies and having in progress or in development several multi-country environmental studies.

This study, therefore, fits well into the series of books that ICEG and HIID have done collaboratively on some of the major issues facing today's developing world and the tools available for dealing with those issues.

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Introduction

Over the past few decades, the environmental policy debate has evolved to recognize the importance of **market-based incentives** (MBIs) as instruments for encouraging pollution abatement. A market-based incentive affects the estimates of costs and benefits of alternative actions, hence influencing the decisions and behavior of individuals, firms, and governments, so that environmentally superior alternatives are chosen. The use of MBIs saves economic resources because decision makers are made aware, through prices, of the environmental implications of their choices. Despite their appeal, most MBIs are difficult to administer and are sometimes politically unacceptable. Therefore, it is imperative that the fiscal instruments designed for pollution control are appropriate to the existing situation.

In this book, we present an overview of the alternative instruments for pollution control. We have included a review of the theoretical foundations of market-based incentive instruments and a discussion of the disadvantages of the traditional regulatory approaches used to control pollution versus the advantages of the market-based incentive approach. Most of the book, however, is devoted to discussing the use of pure fiscal (or tax) incentives to influence pollution abatement. To date, such tax incentives have been the dominant form of market-based incentive employed by governments. We analyze the intent and design of investment tax incentives and their economic and environmental impact by studying specific examples from industrialized countries, as well as reviewing the theory of tax incentive instruments. The purpose is to create a framework for iden-

tifying structural weaknesses and negative behavioral influences, thus introducing the criteria that may be used to evaluate tax incentives. The use of a comparative methodology also suggests structural and legislative modifications of tax incentives that may enhance their effectiveness and promote efficiency.

Chapter 1

Theoretical Foundations of Market-based Incentives

The Demand for Market-based Incentives

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 U.S. 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 1982 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. These 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 2 percent of the total expenditures on pollution abatement.

Third, concern 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.

The Economics of Market-based Instruments for Pollution Control

Efficiency arguments in favor 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 to others of his or 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 (that is, 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 behavior. By imposing this charge on polluters, the cost of pollution is internalized, automatically encouraging them to reduce pollution to the optimal level.

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 a 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 (that is, 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]

The Polluter-pays Principle. Another concept gaining credence among policy makers is the **polluter-pays principle** (PPP). The convergence of the principle and the use of MBIs leads to a critical policy stance—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 favors 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, a market-based incentive embracing the PPP only eliminates the subsidy option from consideration.

The PPP was accepted by the Organization for Economic Cooperation and Development (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 polluter-pays principle and a more effective use of economic instruments, in conjunction with their 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:

1. If they related to industries, areas, or plants where severe difficulties would occur.
2. If they were limited to well-defined transition periods adapted to the specific socioeconomic problems associated with the implementation of a country's environmental program.
3. 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 antipollution 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.

The Regulatory System. To assess the advantages and structure of the market-based 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 noncompliance 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:

1. *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 U.S. DuPont plants.[11] The reason 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.

2. *It discourages technological innovation.* The regulatory approach tends to work 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 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 toward 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 toward corporations and a suspicion that anything supported by business is probably bad for the environment. In fact, for many years, market-based incentives were regarded as "licenses 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 EPA 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 EPA could provide a valuable service by acting as a clearinghouse 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 market-based incentives 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. They are often poorly administered and viewed as being unfair in their application.

Principal Advantages of Market-based Incentives

1. *Cost-effectiveness.* Compared with most regulatory instruments economic mechanisms allow a given degree of environmental protectior to be achieved at lower cost. This is due to the flexibility inherent ir 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 emissions by one ton results in 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 to reduce emissions on its behalf. Since it would cost source A $1,000 to reduce emissions by two tons, there would be a cost savings to the economy of $2,500. The payment from source B to source A is a transfer within the economy and as such is not included as a cost of emissions reductions. An environmental tax set at an appropriate level would have a similar result.

The question of whether to levy a tax based on the amount of pollution emitted, the quantity of production inputs, or the amount of final products needs to be determined based on two considerations: the choice should be easiest to administer and should provide the clearest incentives to reduce pollution.

2. *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:

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

3. *Lower compliance and administrative costs.* Market-based incentives, 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.

4. *Accommodation of growth of existing companies and entry of new ones.* Economic instruments can more easily allow for the expansion

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 market-based incentive 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.

The Measurement Problem

That market-based instruments are theoretically superior to regulatory tools is well established. Nevertheless, despite its many merits, the system of market-based incentives 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 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 s set at the level necessary to attain this target. The level of the charge for ach area necessary for achieving the target level of air or water quality ; obtained by estimating the relationship between different charge levels nd the emissions from different sources based on the average marginal osts of these sources.[15]

In order for MBIs to be most effective, the measurement problem had be dealt with. This led to the introduction of fiscal instruments for vironmental protection whose design philosophy explicitly incorpo- es an environmental agenda. Fiscal instruments for environmental pro- tion are a subset of market-based incentives. Though not always in nformance with ideal market-based incentive approaches, a broad range these instruments can be used to influence pollution abatement. This be accomplished by using both direct and indirect taxes to affect ssions levels. The structure of income taxes, including tax rates, the nition of the base, the relation between corporate and personal taxes,

and loss treatment provisions can be adjusted in order to achieve pollution abatement goals. Examples of these fiscal instruments include tax incentives for investment in pollution-control equipment and technologies, specific taxes on goods and inputs based on environmental externalities, and user charges that account for the true social value of the amenity or service involved.

Chapter 2

Analysis of Investment Tax Incentives

The tax incentives for pollution control available in several of the leading industrialized and newly industrialized countries can be categorized in a few broad categories. They can be differentiated by the nature of the base for determining the tax benefit, the timing of the benefits from such incentives, and the conditionality attached to their use. A taxonomy of tax incentives used for pollution control may be developed by examining tax laws and regulations in selected industrialized countries in Asia, Europe, and North America. While there are important differences in accounting and tax-benefit accrual, the specific incentives encountered are:

- Accelerated depreciation
- Partial expensing
- Investment tax credits
- Tax exemptions/deferrals

These incentives are summarized in Table 1 and outlined in detail in the Appendix.

The most common incentives are provisions for accelerated depreciation and investment tax credits. In order to determine the cost-effectiveness of such provisions, we need to consider the criteria that should be used in evaluating or designing incentives for the control of pollution and environmental damage.

...tax Incentives for Pollution Control

Country	Type of incentive	Details
Japan	Special depreciation	25% initial allowance is permitted—the remainder of investment cost is depreciated normally
	(Expensing) for pollution control equipment	
	No investment tax credit	
Korea	Investment tax credit for pollution control equipment	3% for imported equipment 10% for domestic equipment
	Accelerated depreciation or investment credit for new technologies	30% for imported equipment 50% for domestic equipment Investment credit same as above
Singapore	No special incentives	Three year depreciation available for all plant and equipment
Taiwan	Accelerated depreciation	Depreciation over half of the life of the assets
	Investment tax credits	5% to 20% depending on type of asset
France	Accelerated depreciation for pollution control equipment	50% initial allowance, remainder at 10% to 20% straight-line
	Regional tax concessions and grants are available	
Germany	Accelerated depreciation	60% initial allowance, rest at 10% until full amortization
	No investment tax credit	
Netherlands	Investment tax credit for any environmental protection investment	3% to 15% depending on the type of asset
	Grants and loans to assist research and development projects	
United Kingdom	No special incentives for installing pollution control equipment	
Canada	Accelerated depreciation for pollution control investments on plants commissioned before 1974	3-year straight line 25%–50%–25% vs. normal declining balance depreciation, 20% to 25%
	Investment credits for certain activities, which can include expenditures on pollution control assets	Depends on taxpayer, activity, region, and year involved
United States	No special incentives for installing pollution control equipment	

Objectives of Investment Tax Incentives

Investment tax incentives are specific tax preferences directed toward the purchase of capital goods and services. Besides furthering environmental objectives, these incentives have been used to promote employment, output, investment, productivity, international competitiveness, research, and technological progress.

Most investment tax incentives that operate through the corporate tax mechanism are based on the purchase price of capital assets. Although incentive utilization may be conditioned on positive net profits and other arbitrary percentage limitations, the basis for these tax incentives is in effect the cost of the asset purchased.

One major distinction between tax preferences for pollution control and tax preferences for other purposes is that the equipment investments that enable pollution incentives to be utilized are usually not voluntary. In the case of a general investment tax incentive, the investing entity is free to choose whether to make a given investment or not. In the case of investment incentives for pollution control, the installation of pollution-abatement hardware is often necessary to comply with regulatory standards and permitting procedures. Operationally, however, and in terms of cash-flow impacts, investment tax incentives for pollution control are no different from incentives to invest in other plant and equipment.

Policy makers worldwide continue to use these investment tax preferences since they seem to balance environmental considerations with concerns about industrial competitiveness. Additionally, tax incentives are often politically expedient ways of providing hidden government subsidies for select activities. Tax concessions, or tax expenditures as they are often termed, have a major political advantage over direct cash subsidies since they are usually concealed and are not reported as individual items in the budget.

The Environmental Impact of Investment Tax Incentives

Investment tax incentives for pollution-control equipment and technologies do not promote the active pursuit of pollution reduction, which is the desired goal. In other words, even though an investment tax incentive may be provided for purchases of specific pollution-abatement hardware, the pollution-control investment may only induce more of the polluting activity (the manufacture or production of goods and services).

Entities invest in pollution-control assets only because they are required to do so by law, through environmental regulations. Pollution-control equipment represents a nonproductive asset since it does not produce any income for the investing entity. If investments in pollution-control assets are viewed as independent projects, negative net present values equal to the purchase price plus the discounted sum of the annual operating expenses and allocable overheads are obtained. An investment tax incentive for the same pollution-control asset only improves the net present value by the present value of the incentive; the overall net present value continues to be negative.

When examining an investment incentive for pollution control and the accompanying environmental legislation, it is important to determine whether or not there is a net increase in pollution as a result of the incentive. Not all forms of environmental regulation will result in a net increase in pollution when combined with an investment incentive. We will examine two cases to illustrate this point.

Pure Technology Standard. This standard requires a firm to install a specific technology, depending on the production process in question. For example, all power plants may be required to install flue-gas desulphurizers and precipitators of a specified efficiency.

All the investment incentive for pollution control does is lower the overall cost of the investment in productive plant and equipment. Since investors cannot operate their productive assets unless pollution-control equipment is installed, they view the cost of the equipment as part of the total investment package.

There is no incentive to reduce pollution because all the firm has to do is install certain specified equipment for each level of production. In essence, the investment incentive only subsidizes the value of the entire investment.

In this case, more pollution is created than would be produced without the incentive. In other words, there is an increase in pollution at the margin, resulting in a net increase in pollution.

Performance Standard. Under this standard, the firm is allowed considerable latitude in the choice of methods by which pollution abatement may be achieved. For example, the standard may set a limit on the maximum allowable units of pollutant per unit time, while remaining neutral with respect to the means by which the firm should reach this goal.

Hence, the firm is able to compute an approximate marginal cost and

benefit of polluting based on its options, that is, use no abatement and produce very little of the pollution-causing product (steel or electricity) or use a variety of pollution-control technologies that allow production to be increased. Under both options, pollution must be kept within mandated limits.

There is no incentive to reduce pollution, but neither is there an incentive to pollute more. The investment incentive reduces the marginal cost of abatement without permitting any marginal increase in pollution.

Neutrality of Investment Tax Incentives

Since tax incentives influence behavior, it is important that they result in optimal investment choices—financially, economically, and, by extension, environmentally. In the case of investments to control pollution, a tax incentive that is not neutral will distort the choice of technology used. Such distortions will increase the overall economic cost of pollution control. Neutrality is one measure of the behavioral impact of tax incentives.

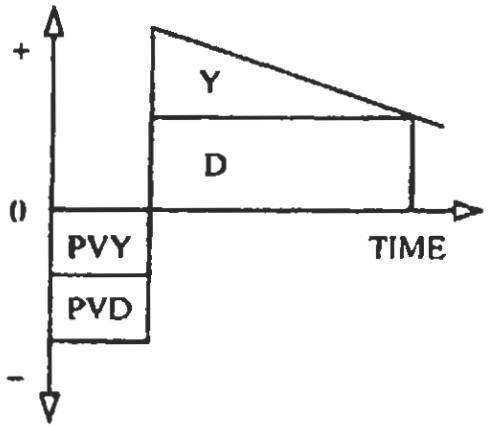
A **neutral tax incentive** is one that does not induce new "covered" investment with low rates of social yield, while failing to induce other covered investments with higher rates of social yield.[16] (Covered investments refer to those that are eligible for the tax preference as per the tax code.)

A depreciable income-producing asset generates a positive gross-of-depreciation income stream of earnings (Y+D) arising from the utilization of the asset, the present value of which can be represented as PVY+PVD, where PVY is the present value of the net income stream and PVD is the present value of depreciation. The gross-of-depreciation income stream is also equal to the market price of the asset. Figure 1 provides a graphical representation of an investment profile.

The asset will diminish in value due to wear and tear over the years of usage. This reduction in value is recognized by tax authorities, who permit a tax depreciation deduction. Tax depreciation must, however, be distinguished from the actual or true reduction in value resulting from the asset's being utilized. This true reduction in value is referred to as economic depreciation, the present value of which is represented by PVD.

For perfect tax neutrality, assets with equal present values of net earnings (PVY) should carry an equal tax burden. In other words, investments with the same present value of net earnings should have the same present value of tax liability.

FIGURE 1 Investment Net Benefit Profile



Accelerated Depreciation. Capital asset depreciation is a cost of doing business. The tax law recognizes this by permitting investors to recover their cost of capital investment. Other costs of doing business, such as wages and materials, are deducted currently, that is, when the payments are made. Depreciation deductions for capital cost recovery, on the other hand, are made over many years.

Under accelerated depreciation, purchasers of depreciable assets are accorded tax benefits, permitting them larger deductions in the initial years of asset operation. The total units of deductions available for accelerated depreciation are the same as under a normal depreciation regime. The incentive is derived from the postponement of the tax liability.

For example, if a company pays $100 less in tax in year 1 as a result of accelerated depreciation, even if it has to pay $100 more in tax in year 2, it is still ahead—if only by the return it earns as a result of having the $100 to use for another year.

Impact on the effective tax rate. The effective tax rate governs the investor's decision concerning the attractiveness of the investment incentive in question. The effective rate of tax depends on both the nominal rate and the rate at which depreciation is permitted. The faster the depreciation rate, the lower the effective rate of tax.

When considering an investment, the investor weighs the present value of its net-of-tax income stream against the cost of the asset. The present value of net income equals the present value of the income stream before

tax minus the present value of tax payments. The present value of tax payments may be viewed as equal to the present value of the taxes on the gross income stream (Y+D) minus the present value of tax savings due to depreciation. The present value of tax savings due to depreciation will be larger when more rapid depreciation is allowed. Accelerated depreciation thus reduces the effective rate of tax by postponing the due date of the tax liability. For the tax incentive to be neutral between two assets, it should result in the same effective tax rate (other factors being equal).

The benefits of accelerated depreciation are also manifest in other forms better appreciated by accountants and financiers:

- A postponed tax liability is a virtual interest-free loan from the Treasury to the firm. This reduces the costs of financing and acquiring new capital, hence improving a firm's cash flow. The characterization of deferred taxes as merely equivalent to an interest-free loan overlooks some of their other advantages. These are best expressed in a statement by Richard Bird: "Who would refuse an interest-free loan available without any strings at all, without having to ask anyone for it, without having to put up any security, and without even having to pay it back unless profits are made in the future?"[17]
- The faster recovery of investment costs reduces recovery risks in the long run.

Distortions generated by accelerated depreciation. Accelerated depreciation changes the ranking of projects depending upon the useful life of the assets. The principal distortion is that accelerated depreciation is more attractive to investors in long-lived assets. The gain from early deductions are larger because the postponed tax payments can be delayed for a longer period when the asset has a longer life.

For example, consider an asset that has a twenty-year life and another with a five-year life. In both cases, depreciation is permitted over two years. For an investor holding the twenty-year asset, the reduction in tax liability that occurs in the first two years is recovered in nominal value over eighteen years, whereas for the five-year asset it is recovered over the following three years of the asset's life. It is evident that the twenty-year asset will be preferred over the five-year asset.

In the case of pollution-control investments, this could influence the choice of technologies selected for a particular abatement task. Countries

which have a marked preference for long-lived assets are Singapore (all assets depreciated in three years) and Germany (60 percent initial expense allowed).

Neutral depreciation. A neutral depreciation allowance is one where assets with the same present value of net income streams carry an equal tax burden. This will be achieved if the net income stream being taxed each year is equal to the gross income flow less the actual diminution in asset value. This is the case where tax depreciation is charged in line with economic depreciation.

If the allowable depreciation equals economic depreciation, taxation will reduce the value of the net income stream by the statutory (nominal) rate of tax. In this case, the effective rate of tax will equal the nominal tax rate irrespective of the length of asset life. Unfortunately, economic depreciation is a theoretical concept that in practice cannot be easily applied.

Typical cases of non-neutral accelerated depreciation. Most accelerated depreciation mechanisms are non-neutral. Though this might seem to be a rather sweeping statement, it should not be surprising considering how difficult it is to measure economic depreciation. Certain mechanisms do exist, however, whereby accelerated cost recovery can be achieved neutrally. Before we examine these neutral accelerated depreciation mechanisms, we will discuss typical methods of providing non-neutral accelerated depreciation. These are:

1. Depreciating assets in a specified number of years, regardless of their true economic life.
2. Allowing assets of different economic depreciation patterns to be depreciated according to a specified method (for example, exponentially).

   Depreciating assets in a specified fraction of time (for example, twice as fast as dictated by true economic depreciation).

The accelerated depreciation provisions of the Taiwanese Statute for Trading Industry is a variation of number 3 above. In Taiwan, depreciation for certain specified assets, including pollution-control equipment,

TABLE 2 Comparison of Two Investment Projects: Depreciation over Half the Normal Life

	Year									
	0	1	2	3	4	5	6	20	21	40
Six-year project[a] (privately unacceptable)										
Gross-of-tax cash flow	−1200	490	450	400	200	140	100			
Depreciation	0	400	400	400	0	0	0			
Taxable income	0	90	50	0	200	140	100			
Tax at 50%	0	−45	−25	0	−100	−70	−50			
Private cash flow	−1200	445	425	400	100	70	50			
Forty-year project[b] (privately acceptable)										
Gross-of-tax cash flow	−1200	205	205	205	205	205	205	205	205	205
Depreciation	0	60	60	60	60	60	60	60	0	0
Taxable income	0	145	145	145	145	145	145	145	205	205
Tax at 50%	0	−73	−73	−73	−73	−73	−73	−73	−103	−103
Private cash flow	−1200	133	133	133	133	133	133	133	103	103

NOTES: Blank cells: not applicable for project or not given for readability.
a. Internal rate of return: social, 17.2%; private, 9.8%. Net present value: private NPV at 10% is −3.6.
b. Internal rate of return: social, 17%; private, 10.5%. Net present value: private NPV at 10% is 55.5.

may be accelerated by up to half the number of years of normal service life.

This particular incentive leads to a general shortening of depreciation periods without distorting the ordinal ranking of asset lives. More specifically, long-lived assets end up with longer depreciation periods than do short-lived assets. The result achieved by cutting the depreciable life of assets in half appears to distort the process of project selection significantly less than many of the alternative schemes of accelerated depreciation.[18]

Nonetheless, it is still possible to find examples that violate the criterion of neutrality. For illustration, we take a pair of projects with six-year and forty-year normal lifetimes respectively (See Table 2). We allow the assets to be depreciated over half the normal life of the projects. While the comparison may seem exaggerated, the fundamental effects of the interferences are easily and quickly underscored. Let us also assume a 10 percent private after-tax discount rate.

The project with a six-year lifetime will be rejected since it has a private after-tax return of only 9.8 percent, despite its high social return of 17.2 percent. On the other hand, the project with a forty-year lifetime will be accepted privately, despite the fact that its social rate of return is

only 17 percent, because its private after-tax return is 10.5 percent. The non-neutrality results in the first project with a social return of 17.2 percent being rejected and the project with the lower social return being accepted.

Can accelerated depreciation be made neutral? Accelerated depreciation allows full capital cost recovery over a period that is less than the life of the asset. It is still possible to achieve neutrality when using accelerated cost recovery as the appropriate tax policy for a particular class of investments. The neutrality criterion will remain inviolate if the following two methods are used:

1. *Immediate expensing (cost write-off):* This is also called Musgrave Neutrality, after Richard Musgrave, who first showed that allowing the full expensing of investment outlays and the subsequent full taxation of the gross income stream results in an effective tax rate of zero. Hence, the immediate expensing of the purchase value of an asset ensures the same effective rate of tax on all investments.[19] Full and immediate expensing results in a totally neutral income tax with respect to different economic lives and differently shaped time profiles of net benefits.

Expensing allows for the instantaneous depreciation of assets at the moment of purchase. Since nothing is left to depreciate in the future, it pays the same rate of tax on net income in each period. Though none of the countries we reviewed have an immediate expensing provision in place, the Netherlands has considered to have such a law adopted.

2. *Partial expensing with economic depreciation of the remainder:* This scheme is also called Harberger-Bradford Neutrality. A portion of the asset cost is immediately expensed, while the remainder is depreciated over the life of the asset as a fraction of the true economic depreciation. This fraction is equal to the percentage that was not expensed initially.

Some of the countries reviewed have allowed partial expensing for pollution-control investments, with normal depreciation deductions taken for the remainder. This should not be confused with Harberger-Bradford neutrality. However, it does reduce the extent of distortion between asset choices, while allowing the investor to benefit from a postponement of the tax liability. This method is being used in Japan, Germany, and France.

- Japan — 25 percent initial allowance, remainder to be depreciated normally (the ordinary depreciation allowed in the tax code)

- Germany — 60 percent initial allowance, remainder at 10 percent until full amortization
- France — 50 percent initial allowance, remainder at 10 to 20 percent straight-line

Investment Tax Credits. The investment tax credit is similar to accelerated depreciation in that it reduces the present value of tax liability, but it has a different mechanism. The investment credit involves not merely a tax postponement, but an outright tax reduction as well.

Disagreements exist concerning the design and structure of investment tax credits. Nevertheless, it is worth noting that in ranking various incentives, such as accelerated depreciation, investment credits, and reduced nominal tax rates, there is virtual unanimity that the investment credit will produce the most new investment per dollar of revenue forgone.[20]

The Netherlands is an example of a country where the superiority of investment tax credits over accelerated depreciation has been recognized. Accelerated depreciation and other tax allowances in the previous code were replaced with investment tax credits.

Uniformly applicable investment tax credits are in some ways fiscal substitutes for investment stimulants that should normally be accomplished through monetary policy. However, monetary stimulants may not always result in business investment. The argument might, therefore, be made in favor of directed investment tax incentives.[21]

In most cases, the tax credit is given as a percentage of the purchase price of the assets. Credits are not usually refundable—they can be claimed only against a positive tax liability. To facilitate a more equitable treatment of those with and without taxable profits, credit carryover and transfer schemes may be provided. Canada, for example, has experimented with refundable research and development tax credits.

These schemes have an important impact on the effective utility of legislated investment credits. Investment tax credits reduce the amount of financing required by reducing the acquisition cost of capital assets, and hence the overall cost of capital. For accounting purposes, the depreciable base of the asset can either be maintained at the original purchase price or adjusted for the tax credit.

Many variations of the relationship of the credit to the depreciable base exist. In 1983, the Canadian system of investment tax credits reduced the accounting base by the full tax credit value, while in the United States the basis was reduced by only half the credit. Korea, on the other hand, does not reduce the depreciable base of the asset by the value of the credit.

Irrespective of the final depreciable base available to the firm, an investment tax credit translates into a cash subsidy proportional to the size of the investment in the qualifying asset.

Distortions created by investment tax credits. The investment tax credit works in favor of short-lived assets. This is in contrast to accelerated depreciation, which favors the long-term fixed investment.

A simple exercise using government bonds as illustration gives a striking example of why tax credits perpetuate this bias. Assume that a government passed a law granting a subsidy of 7 percent of the purchase price to everybody buying a newly issued government obligation. Suppose that the available government obligations were perpetuities, twenty-year bonds, one-year bonds, and ninety-day bonds.

If the interest rate were 1 percent per month, the bonds would have a yield of 10 percent every ninety days. As a result of the tax credit, everybody would rush to buy ninety-day bonds. No one would buy one-year bonds, let alone perpetuities, since a subsidy on the purchase price of an asset is biased in favor of short-lived assets. This occurs because the subsidy covers not only the present value of net return, but the present value of depreciation (amortization in the case of bonds) of the asset as well.

The problem with this non-neutrality would be manifest in a scenario where a project with an unacceptable social rate of return—that is, having a gross-of-tax return below a socially acceptable hurdle rate but having a privately acceptable net-of-tax return—would be favored over one whose social rate of return is acceptable.

An illustration of socially suboptimal project choices is shown in Table 3, where two projects with different asset lives have been compared. In both cases, a 30 percent investment tax credit has been made available.

Even though the first project has a negative social return, it clears the private hurdle rate, while the second project, despite providing a higher social return, will not be privately chosen. Such distortions created by investment tax credits force one to question the logic of providing government subsidies for projects that have a detrimental social impact.

In the context of environmental protection, therefore, it is possible to choose an environmentally inferior project over one that is environmentally friendlier. Under this scenario, the objective of the pollution-control incentive is not realized.

Neutral investment tax credits. An investment tax credit subsidizes the purchase price of an asset. At the beginning of our discussion of investment

TABLE 3 Comparison of Two Investment Projects: each with 30 percent tax credit

	Year				
	0	1	2	3	Infinity
Short-lived project[a] (privately acceptable)					
Gross-of-tax cash flow	−1500	450	450	450	
Tax credit at 30%	450	0	0	0	
Depreciation	0	500	500	500	
Taxable income	0	−50	−50	−50	
Tax at 50%	0	−25	−25	−25	
Private cash flow	−1050	475	475	475	
Long-lived project[b] (privately unacceptable)					
Gross-of-tax cash flow	−1500	135	135	135	135
Tax credit at 30%	450	0	0	0	0
Taxable income	0	135	135	135	135
Tax at 50%	0	−67.5	−67.5	−67.5	−67.5
Private cash flow	−1050	67.5	67.5	67.5	67.5

NOTES: Blank cells: not applicable for project.
[a]Internal rate of return: social, −5%; private, 17%. Net present value: private NPV at 10% is 131.
[b]Internal rate of return: social, 9%; private, 6.4%. Net present value: private NPV at 10% is −375.

incentives, it was shown that the purchase price or value of the asset is equal to PVY+PVD, that is, the gross-of-depreciation flow of benefits attributable to the asset. If r is the rate at which the investment credit is provided, the investing entity gains

$$r(\text{PVY}+\text{PVD})$$

For the incentive to be neutral across all investment classes (within a given industry group), the tax incentive should ensure that all assets with equal present values of net earnings (PVY) carry an equal tax burden. For an investment tax credit to be neutral, therefore, the ratio of PVD to PVY should be the same for all investments, that is, PVD/PVY should be equal for all investments. However, since PVD depends on the service life of the asset, there will be a marked preference for shorter asset lives over longer ones.

Nevertheless, it is possible to structure a neutral scheme of investment tax credits.[22] To do so would require that the credit be granted on net, rather than gross, investment for the year. In other words, the credit should equal r(PVY). This satisfies the requirement that incentives be provided at an

equal rate across all investments eligible for the tax credit, thereby promoting neutrality.

Of the countries reviewed, Korea, the Netherlands, Canada, and Taiwan offer investment tax credits. The rates range from 3 to 20 percent. In the case of Taiwan, the rates are moderated by a limitation that restricts the credit to only half the tax due. None of the schemes in these countries will be neutral across all classes of eligible investments.

Chapter 3

Evaluation of Investment Tax Incentives for Pollution Control

Criticisms of Investment Tax Incentives for Pollution Control

Even though tax incentives do influence behavior, there is criticism concerning their inclusion in the family of market-based incentives. Investment tax incentives do not conform to the tenet of influencing environmentally superior choices that is mandated by an inflexible and exacting definition of market-based incentives. These incentives have sometimes been termed "pseudo-incentives."[23]

> Other common instruments, such as tax write-offs, accelerated depreciation, low-interest loans or outright subsidies for the adoption of "clean" production technologies, or the construction of waste treatment facilities are similarly inefficient and ineffective even though they can pass as economic incentives; it is the wrong kind of incentive. They do not make waste reduction or waste treatment any more profitable; they simply subsidize the producers and consumers of the products of these industries. Waste treatment is not always the most efficient means of reducing wastes; in many cases changing production processes, the type and quality of raw materials or the rate of output is more efficient. . . . Tax breaks, credits, depreciation allowances, and subsidies are a drain on the government budget and a disincentive to industries which might have otherwise developed more efficient methods for reducing emissions.[24]

This criticism is not completely accurate since there may be reasons for governments to provide an investment subsidy via a tax incentive for pollution abatement. For example:

1. Even though pollution standards may be mandated by regulation, they may not be well enforced. Under these conditions, the government may decide to encourage the purchase of necessary pollution-control equipment by offering tax incentives.

2. Older plants and production facilities may find it financially debilitating to install pollution-control equipment. Without the financial assistance to do so, these plants may be forced to close down, resulting in unemployment. The government may find the benefit of contributing such a subsidy greater than the cost of providing the tax incentive.

Finally, the fact that tax incentives are effective subsidies has come under criticism. These subsidies have sometimes been confused with a subsidy-to-pollute, therefore generating a myth that polluters would find it attractive to cause more pollution. In reality, investment incentives are used in conjunction with environmental regulation that expressly specifies acceptable pollutant levels. Therefore, the subsidy is for equipment purchase, not for the generation of more pollution.

Criteria to Evaluate Investment Tax Incentives

If tax incentives are broadly applicable to all investments, their evaluation is greatly simplified. The advantage of a generalized evaluation model that treats all investments similarly (that is, assumes that tax incentives are available to all classes of assets) is that no distinctions need to be made regarding the physical characteristics of the investment project. However, incentives for pollution-control investments by definition target a selective class of assets. Consequently, they do not directly lend themselves to such a general analysis.

In order to proceed with a meaningful evaluation, the following words of caution are in order.

Focus on intra-industry investment distortions. Narrowly defined investment incentives are aimed at inducing investments in certain technologies and industry groups, that is, certain sectors are preferred over others. In a pure economic sense, most narrowly defined incentives create distortions, since alternate investment choices are being influenced by the tax system. It is only in cases where an externality is being offset that an investment incentive would correct for a distortion. With incentives being available

for certain explicitly stated activities, it is evident that tax policy is being used as an instrument to meet other policy objectives.

These distortions between the investments undertaken in preferred areas and those in other industrial activities must be accepted. Tax incentives, however, should not influence choices within the same preferred category. It is important that the ranking of projects within the same sector not be changed by the incentives.

Watch for the presence of perverse incentives. Perverse incentives in the context of environmental protection refer to situations where the tax factor results in investment decisions that are incrementally more polluting. In most of the countries surveyed, incentives for pollution control are available principally for equipment purchases. This creates a bias against the adoption of cleaner production processes that minimize the need for pollution-control equipment. Thus, despite encouraging the installation of control equipment to achieve an aggregate reduction in pollution levels, the same incentives could act as a barrier to long-term emission reductions.

For example, in paper pulp production, additional upstream pulp processing to remove lignin can be used. The more lignin removed upstream, the less chlorine needed to bleach the pulp. A reduction in the chlorine requirement greatly reduces downstream water treatment and toxic discharges. Since the upstream ventures may not be eligible for the investment incentive, there could be a bias toward using the older process, requiring more water treatment and causing more pollution.

It is difficult to measure the extent of this bias. Nevertheless, it should remain in perspective during any analysis of tax incentives for pollution control.

Cost-effectiveness of Investment Incentives for Pollution Control

Cost-effective utilization of investment incentives for pollution control requires that the marginal cost of the abatement effort be less than or equal to the marginal benefit derived from the reduction. The principles of cost-benefit analysis form the analytical foundations of this criteria.

A general investment tax incentive for pollution-control equipment does not differentiate between the marginal control costs of various pollution sources. Expressed differently, a general incentive tacitly assumes that marginal control costs are the same across all sectors.

Costs can be broadly defined to include direct costs, such as investment costs undertaken. Additionally, there are indirect welfare costs resulting

issue is whether the growth in income and consumption would be consistent with the desired level of environmental protection.

Efficiency of Investment Incentives

A *more* efficient tax system is described as one that interferes *less* with the market's allocation of resources. With reference to tax instruments for environmental protection, two guidelines of system design must be adhered to. First, and most directly relevant, is the balancing of social costs and benefits, which focuses on the use of the tax system to counteract negative externalities. These externalities, if left unaffected by economic policy, will result in a suboptimal (or inefficient) allocation of resources. The most efficient incentives are those that relate most directly to the activity being encouraged. To conform to this guideline, the incentives should be applied only to new, additional, or marginal activities. The reasoning behind this principle is that any activity being carried out in the absence of an incentive clearly does not need it to bring about that activity. If the incentive is nevertheless granted, it will be redundant or inframarginal and will amount to a windfall for the recipient.[30]

The second guideline for assessing tax system efficiency is the principle of neutrality. Under the given conditions of selective tax preferences, the most comprehensive definition is the one stated earlier by Harberger: a neutral tax incentive is one that does not induce new covered investments with low rates of social yield, while failing to induce other covered investments with higher rates of social yield.[31] (Covered investments refer to those that are eligible for the tax preference under the tax code.)

To illustrate further, let us consider a preferred group of assets, that is, one covered by the tax incentive. Suppose that in the absence of a tax incentive, corporate investments at the margin typically yielded a 20 percent rate of return gross-of-tax and a 10 percent rate net-of-tax. The introduction of a tax incentive would cause more investments to become interesting from the private standpoint. Neutrality within the preferred category requires that an investment stimulus make all investments with gross-of-tax above a critical level (for example, 18 percent) acceptable, while not encouraging any with gross-tax yields that are less than that level. Making the incentive more generous would admit all investments with gross-of-tax yields of, say 15 percent or more, but none with yields of less than 15 percent. For each level of stimulus, neutrality requires some rate of social return that will tend to encourage all independent investment

projects meeting that rate to be privately accepted, while discouraging the private acceptance of projects failing to meet it.

Tax incentives that affect the net-of-tax return for all investments at an *equal rate* have the property of reducing the critical level of expected marginal productivity in a very orderly manner. Under such an incentive regime, it would be possible for the government to have a normal tax administration in which the gross-of-tax rate of return was 20 percent per annum, a preferred category in which this rate was 16 percent per year, and a super-preferred category in which the cutoff rate was 10 percent per annum.

Each such category should be free from cases in which the incentive structure leads to the acceptance of an inferior alternative (for example, with a 14 percent rate of social return in the 16 percent per year category), while other alternatives covered by the same category are rejected, even though they have a higher (for example, 17 percent) rate of social return.

Policy Implications of the Evaluative Criteria. The ability to justify the use of an investment incentive for pollution-control equipment on the basis of these evaluative criteria suffers from three major problems.

1. There is an implicit divergence from the polluter-pays principle, which is fast becoming a dominant determinant in using economic instruments. While there are political reasons for providing a hidden tax-expenditure subsidy through a general tax incentive rather than an outright cash subsidy, the fundamental issue is that polluting activities are being subsidized without affecting pollutant levels.

More specifically, the use of investment incentives indicates a lack of focus on the broader issues of environmental protection. Allowing deductions for environmental expenses in the absence of a policy agenda to deal with specific environmental problems is much like trying to fit a square peg into a round hole.[32]

2. Focusing on the measurement of tax incentive effectiveness and efficiency actually distracts attention from the central task of determining the socially optimal level of pollution reduction. The use of an investment incentive amounts to a rejection of the basis on which the optimal total pollution load was determined when formulating environmental protection regulation. Strictly, an acceptable pollution load must be determined before an appropriate incentive can be designed to eventually achieve this goal.

A tax incentive, however, distorts the relative price signals otherwise provided by economic instruments that may reduce pollution and may in

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as mechanisms to counter the adverse impact on international competitiveness due to the increasing costs of environmental compliance. By extension, one could search for benefits manifested in the form of an incremental improvement in the terms of trade (TOT).

In one study that used a partial equilibrium framework to measure the impact of marginal changes in industrial pollution-abatement costs on the U.S. balance of trade in general, and its balance of trade with Canada in particular, the following conclusions were reached.[26]

- The impacts were found to be negative for most industries. They grow with trade volume and are small relative to domestic consumption.
- Some evidence was found that pollution-control programs have changed the U.S. comparative advantage such that a greater number of high-abatement-cost goods are imported and more low-abatement-cost goods are exported.

The above results are not unexpected since they emphasize the inefficiency of regulatory pollution-control schemes rather than support the use of investment tax incentives. An earlier study in the United States also pointed out that air pollution abatement costs could be reduced 40 to 90 percent if a more efficient regulatory scheme were employed.[27]

Measuring Improvements in Economic Growth Rates. Investment incentives have also been rationalized as necessary for reducing the impact of environmental regulation and its associated cost on economic growth rates. It is argued that investments in pollution-control devices crowd out investments for capital accumulation, thereby further reducing the rate of economic growth.[28] In an effort to determine the impact of nonproductive pollution-control investments, models have been developed that were designed to plot the transition path of the U.S. economy after investment requirements for pollution control were eliminated. Results indicate that in the long run, real GNP would rise by a maximum of about 1.29 percent, the exchange rate would appreciate by 0.462 percent, consumption would increase by 0.489 percent, and capital stock would rise by 2.266 percent as a direct result of the drop in the price of investment goods.[29]

Though these numbers seem to indicate substantial economic opportunities forgone as a consequence of the costs of pollution control, the real

fact be counterproductive. In fact, a recent study in Canada suggests that the removal of subsidies may be a more effective way to reduce pollution levels, particularly in those sectors most favored by government subsidies.[33] This was found to be the case for subsidized sectors like mining and primary metals processing.

3. Tax incentives can reduce the variance between firms in the costs of curbing pollution, thereby reducing the effectiveness of other economic instruments such as tradeable permits. For example, wider variances in costs ensure the development of markets for tradeable permits because they generate a stronger incentive to trade. Subsidies can reduce the absolute, and in some cases, the relative difference, in costs and cause potential trading opportunities to be depressed.

Improving the Effectiveness and Efficiency of Investment Incentives

The criteria just discussed may be used to determine the weaknesses and other inconsistencies of investment tax incentives. Though the incentives may be appropriate for promoting nonpollution-related objectives, their relevance to pollution abatement and control is gradually diminishing. However, as tax incentives for pollution-control equipment address multiple policy objectives they continue to be used.

An examination of the structural differences in incentive design reveal these multiple objectives. Although the incentives can be grouped under the broad headings of accelerated depreciation, investment credits, and expensing, differences in accounting procedures and eligibility requirements, as well as conditionality clauses, exist.

Some of the differences legislated include:

- Differentiation between imported and domestically supplied pollution-control equipment, evidenced in Korea and Taiwan
- Differentiation based on plant age, as is the case in Canada
- Differentiation based on administrative and accounting procedures adopted, such as the use of blue tax returns in Japan
- Differentiation based on the type of technology, that is, the provision of greater incentives to use advanced or pioneering processes

or equipment, which is illustrated by Taiwan, Korea, the Netherlands, and Canada

In a few cases, these distinctions have helped improve the environmental cost-effectiveness and economic efficiency of the tax incentives. This section analyzes a few mechanisms and structural aspects of tax incentive design that could enhance their efficacy. A comparative perspective is used wherever possible.

Qualifying Eligibility Based on Plant Age. This eligibility clause has been used in Canada to restrict the tax incentive to older production facilities. Pollution-abatement costs vary greatly based on plant location, process used, and plant age. An efficient pollution-control incentive will account for these differences. The cost of installing pollution-control equipment in older plants and facilities usually has a much larger impact on operational cost than the installation of similar equipment in newer facilities. Often, this implies requiring newer (more modern) plants to make greater emission reductions, while older facilities with expensive control options may make fewer reductions.

In effect, the marginal cost of achieving a given level of pollution abatement through investments in pollution-control equipment is lower for newer facilities and higher for older facilities. There will be older facilities, however, whose pollution burdens place unacceptable costs on society. The authorities are then left with no choice but to close the plant, risking unemployment. Alternatively, the reduction of emissions levels may be required of all plants in order to meet minimum ambient standards. Under these circumstances, the case for providing some assistance to older facilities could be made.

Canada has targeted the incentive, or subsidy, to the older plants, making accelerated capital cost recovery available to facilities commissioned before 1974. (See the Appendix for a description of the Canadian accelerated depreciation allowances.)

Impact on New Investments. New or young firms do not stand to gain the same benefit from tax incentives that older, more mature enterprises enjoy. The larger tax benefits accrue to existing (or older) facilities because they tend to have positive tax liabilities that can be reduced when they claim deductions or credits on new investments on pollution-control equipment. The impact of these tax incentives on new investments are reduced or eliminated for those investors who expect to suffer tax losses in the

initial years after making an investment. In other words, tax deductions and exemptions are of benefit mainly to those who have an operational enterprise with a positive tax liability. For start-up enterprises, this is rarely the case.

Even in cases where the enterprise is likely to be immediately profitable, it will often be unable to utilize fully all the investment incentives offered. A barrier to innovation is introduced as a result of favoring owners of old capital over new entrepreneurs.

To make investment tax credits and capital cost allowances more attractive to new enterprises that do not foresee taxable income for a few years after start-up, provisions for treating unclaimed tax preferences are necessary. These could include:

- Carry-over of unused preferences
- Provisions to transfer unused preferences to unconnected entities

There are two perspectives on the issue. First, there is the argument for eliminating the bias against new enterprises. Second, from a government perspective, granting an incentive whose benefits cannot be fully realized will decrease the level of tax expenditures in the budget. It is, therefore, possible that revenue collections would not be reduced much by the granting of such incentives. Politically, however, the objective of encouraging an optimal level of social investment in pollution-control equipment is normatively achieved.

Carry-over provisions. Provisions to carry over unused tax preferences enhance the incentive to invest in pollution-control equipment. These provisions usually allow a firm with unused tax credits and/or deductions to utilize them in future years. In most investment cash profiles, the likelihood of substantial positive cash flows in the initial years is small. Even if there are significant positive cash flows in the initial years, other deductions for normal depreciation and interest expenses can considerably reduce the value of the investment incentive.

Most countries allow unused tax preferences to be carried forward for a specified number of years. Taiwan, for example, permits a four-year carry-over period. Singapore, as an extreme example, permits unused tax incentive allowances to be carried forward indefinitely.

Transfer of unused tax preferences. In some cases, an enterprise may be unable to utilize all its tax preferences within the specified carry-over

period. More importantly, the longer an unused tax preference is carried forward, the lower its value. Therefore, even if countries have a carry-over provision, there will still be a bias against new enterprises.

If the investing entity were allowed to sell or transfer its unused tax preferences to another entity that was able to use the deductions or credits currently, it stands to gain a greater value for the tax preference. Alternately, the government could provide a cash refund for the unused tax preferences. However, this could be administratively difficult or undesirable due to revenue constraints. Canada and the United Kingdom use refund mechanisms for research and development (R&D) tax incentives.

It is interesting to note that studies have found direct refundability to be more efficient than mechanisms to facilitate the transfer of unused tax preferences. Evidence of this was found in Canada, where flow-through shares were used as a form of tax-based financing for corporations in the natural resource sector. These shares were sold as tax preferences to investors, who could use them to reduce their taxes payable.

For the transfer of unused preferences between the entity issuing the flow-through shares and the investor who can use the tax preferences to be efficient, the net revenue cost to the government should be the same as the net benefit received by the issuing entity. It was found that for every dollar of revenue forgone by the government in offering the tax preference, the enterprise received approximately forty cents, owing to inefficiencies in the flow-through arrangement's transfer of the unused preferences.[34]

A system whereby tax preferences could be sold to other nonrelated entities, previously available in the United States, was repealed in 1983. The allowance was directed to firms that had no taxable income in the early years. It was called the "safe harbor" scheme and operated through a leasing arrangement.[35] Firms without taxable income could sell their depreciation allowances and investment tax credits to corporations with taxable income.

Providing Incentives for Pollution-control Research. To further the objective of environmental protection, some countries have decided to provide incentives for research and development in the area. It is possible to extend the debate and argue that tax incentives should be provided exclusively for R&D activities in pollution control and not for equipment installation in production facilities.

Innovative activities in the research and development of pollution-control equipment entail financial risks for the parent entity. Funds diverted toward basic R&D activities have traditionally been accorded various

incentives, ranging from deductions, tax credits, and direct subsidies to a host of other incentives. Support for these incentives has been predicated on the grounds that such tax-expenditure items do indeed yield benefits in excess of the present value of the budgetary costs. Since these incentives reduce the effective cost of capital faced by the firm or entity, they can also be thought of as a way for the government to share in the financial risk of the research activity.

R&D incentives have been the topic of intense policy and legislative debate. There is a belief that private firms would not carry out sufficient research activity from a social perspective if they did not expect to capture enough of the benefits for themselves. It is, therefore, argued that this presents a clear case for public subsidies.

From the policy angle, while there are clear reasons for public support, it is not entirely clear that tax incentives are the appropriate subsidy mechanism for private research and development. Government support of basic and applied research at research institutes and universities may be the better investment. In addition, it would ensure that the knowledge generated would become a true nonexclusive public good—available to everyone.

The legislative problems with R&D tax incentives, however, are of greater direct concern. Most of these problems lie in the definition of what constitutes research and development in the context of profit-making taxable entities. Since one of the reasons for considering R&D tax incentives is to encourage welfare-enhancing activities that would not have been carried out otherwise, a good definition should distinguish between these activities. In other words, R&D that would be conducted as part of routine business development should be separated from that which is sincerely done for the purpose of advancing scientific knowledge or technologies.

Among the countries that have provided extensive tax incentives for research and development in the area of environmental protection is the United Kingdom. Research and development has been specifically singled out for preferential treatment, at the exclusion of all other tax preferences for investments in pollution-control equipment.

Deductibility of Future-period Costs. Many industries face the problem of matching future reclamation costs (incurred after the income-earning process has ended) with current income. Reclamation and abandonment problems have been recognized, if not completely resolved, in nuclear power generation and offshore oil and gas operations. A perfect example

is the problem faced by mining companies needing to deduct reclamation costs incurred after the mine has run out of ore.

It is imperative, both for encouraging industrial activity and protecting the environment, that such costs and legal responsibilities be explicitly clarified. Tax treatment is closely related because of issues about whether these costs should be considered expenses and how they should be timed. Tax preferences enter the picture in cases where these costs can place an unacceptable burden and force closure. Under these circumstances, the government may wish to help the firm create a reserve designed to meet these future-period costs.

The argument against providing a means of matching anticipated future costs with current-year income and profits is that future costs are unascertainable because they are contingent.[36] It is necessary to determine how to decide whether such future reclamation and shut-down costs should be made deductible. The Canadian Income Tax Act prescribes three tests:

1. Is a liability that will require the expenditure of funds in the future an "expense"? It is necessary to first ascertain whether the liability is current, future, or contingent in order to answer this question. We must then determine whether the amount of the expense is determinable or just an estimate.
2. If such a liability can be viewed as an expense, was it incurred "for the purpose of gaining or producing income"?
3. If such a liability can be viewed as an expense, is a deduction prohibited because it is an expense "on account of capital"? (This test tries to establish whether there are any "enduring benefits" or "lasting advantages" to the taxpayer.)

Capacity to Absorb Tax Preferences by Firm Size. Tax incentives are not uniformly neutral with respect to firm size. There are two explanations for this phenomenon. It has been noted that most firms do not really conduct the investment profitability calculations needed in order to make full use of the available incentives. However, larger firms seem more likely to do so.[37] The implication is that large firms may absorb incentive benefits more completely and thus become still larger.[38] The chief benefit may be assumed to be the lower aggregate cost of capital.

The second explanation is essentially an issue of cash flow, or more specifically, the presence (or absence) of taxable income. Larger firms, with their multiplicity of activities having different project vintages and cash-flow profiles, are well positioned to utilize tax preferences by

consolidating their income. Small firms have less flexibility in this regard. Consequently, they are often unable to consume their allowable tax credits and deductions. This problem is very similar to the one between start-up enterprises and older firms. A retrogressive solution to the problem would be to restrict tax benefits to individual operations, that is, ring-fencing of investment activities. The more progressive approach would provide some appropriate means for the complete utilization of tax preferences.

Defining a Pollution-control Investment. To ensure that the incentives provided are accessible only to those investments intended for preferential treatment, clear and unambiguous definitions are necessary to ease the administrative burden and curtail abuse. In the case of Taiwan, the legislation uses the terms "pollution-control equipment" and "pollution-control technologies."

"Pollution-control equipment" is defined as any equipment that handles, inspects, or tests pollution or scrap created during the process of production or operation in order to meet the standards or prescriptions of environmental protection. Eligible items include the equipment and related civil facilities for air pollution control, water pollution control, treatment of scrap, and environment inspection and testing.[39]

"Pollution-control technology" includes any patent rights or technological know-how that is required to be used in conjunction with the pollution-control equipment.[40]

Problems of definition. Definition becomes an issue in tax design when coverage is selective. It is a problem not specific to the treatment of pollution-control equipment or technologies, but equally applicable to selective taxation in any context. If pollution-control hardware and technology are homogeneous and have only a single use (pollution control), the classification or definition exercise is greatly simplified. However, there are numerous types of equipment and processes, some of which can be used for other nonpollution-control tasks, and this serves to complicate matters.

For example, a mechanical screen designed to prevent solid contaminants from entering a water body can rightly be considered as pollution-reducing. The same screen, however, may also be used to prevent solid debris from entering the plant's cooling system or other auxiliaries. This constitutes a nonpollution-control operation contributing only to process efficiency. Should this expenditure also be eligible for a tax preference?

The dilemma for a legal draftsman is whether to be explicit and risk

leaving out potentially beneficial technologies or to provide a broad definition and risk tax abuse, with an associated revenue loss.

Taiwan uses a fairly broad definition. Japan, on the other hand, uses a detailed listing of equipment eligible for special preferences. The classification promulgated by the Japanese Ministry of Finance Notification is based largely on equipment, rather than processes. The types of antipollution machinery and equipment for which tax preferences are allowed include the following:[41]

- Equipment for the disposal of waste oil from ships (including oil separators, incinerators, and other accessories)
- Desulphurization equipment (including hydrogenating desulphurizers of hydrocarbon oil, etc.)
- Sewage treatment systems (including attachments to equipment or structures such as conveyors, measuring instruments, automatic regulators, etc.)
- Smoke treatment facilities (including ventilators, heat exchangers, transformers, etc.)
- Malodorous substance treatment systems (including exhaust pipes, gas coolers, dust collectors, air compressors, etc.)
- Noise control systems (including silencers, sound arresters, forging machines, etc.)
- Industrial waste disposal facilities (including incinerators, devices to make hydrocarbon oil form waste plastics, etc.)

There are no fixed formulas that could eliminate abuse. The trade-off a tax department must make is between maintaining a technical staff to audit incentive claims and providing a detailed (but never up-to-date) current list of equipment and processes.

Chapter 4
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 sources of environmental pressures
- 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, 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
- Setting an appropriate tax rate

Overview of Environmental Tax Design. 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 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.

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.[42] 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, the application 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 the national constitution, size of the nation, existing structure of administrative law, etc. Following is a brief discussion of the division of taxation powers in the United States, which has a federal government structure.

In the United States, water pollution control was 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 Army 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 and state roles. Thereafter, state regulation is allowed only under strict federal supervision.[43]

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.[44] 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 U.S. 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.[45]

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.

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.

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 excise 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 favorable 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.[46] This is both to avoid having to constantly deal with disputes that could arise and to provide an objective legal basis for resolving disputes that do arise.

Two examples of base definitions in existing environmental taxes will help with understanding this concept: the effluent charge base definition in Germany and the excise tax base on ozone-depleting chemicals definition in the United States.

The definition of the effluent charge base in Germany. The German Effluent Charge Law (ECL) provides the states (*lander*) with the power to levy charges on direct discharges into public waters of specified effluents.[47] Firms and households discharging into municipal sewage facilities are not charged directly.[48]

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 law contains all the data needed to calculate the wastewater discharge

bill or tax. The pollutants considered for purposes of effluent charges are settleable solids, chemical oxygen demand (COD), cadmium (Cd), mercury (Hg), and toxicity for fish. In the first step of base definition, the law establishes the discharge right and includes all the physical, chemical, and biological data and monitoring procedures pertaining to wastewater quality.[49] 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 wastewater 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 meter of discharge volume or per ton of product produced.[50] 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.[51] 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.

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 U.S. Revenue Reconciliation Act of 1989.[52] These provisions impose an excise tax on ozone-depleting chemicals (ODCs) sold or used by importers, manufacturers, or producers 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 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 importer or manufacturer sells or uses the ozone-depleting chemical.

The definition of the base is fairly simple and is easily applied when the ozone-depleting chemicals are used in a virgin state. However, complexities arise whenever (1) 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 (2) 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.

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.

Considerations about Whether to Tax Pollution, Production Inputs, or Final Products. The question of whether to levy a tax based on the amount of pollution emitted, the quantity of production inputs, or the amount of final products needs to be determined based on two considerations: the choice should be easiest to administer and should provide the clearest incentives to reduce pollution.

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. France has had the most experience with emission taxes, and studies have shown that the rates were set too low to provide much of an incentive for improving environmental decision making.[53] It was found that to have the desired effects the levels in most cases would have to be quadrupled.

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.[54]

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 behavior 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.

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 than unleaded gasoline because it is environmentally more damaging.

Environmental taxes on inputs have three important advantages:

1. 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.
2. 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.
3. 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 U.S. and Danish taxes on chlorofluorocarbons (CFCs) have been difficult to administer because they also raise complex issues, such as determining the treatment that should be accorded 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 among the various mechanisms that can be technically designed into the structure of the charge in order to achieve a given environmental target.

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.

Chapter 5

Deposit Refund Systems and Tradeable Pollution Permits

Deposit Refund Systems

Deposit refund systems are based on 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
- 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—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.[55] There have also been efforts to establish a nationwide program requiring mandatory deposits.

Deposit refund programs 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—for example,

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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 earlier, 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 potentially 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 (bottles and cans), lead-acid batteries, used lubricating oils, and other industrial chemicals. In each of these cases, the cost-efficiency and design issues often differ due to implicit public policy concerns or objectives, as well as to the physical peculiarities of the substance itself. We will thus deal with each of these cases in turn in order to address the design methods of a workable deposit refund scheme.

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.

Definition of "beverage." There is a need for a definition of the term "beverage," which would often explicitly exclude dairy products, natural fruit juices, wine, and other alcoholic beverages except beer.[56]

Disposable containers. 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.

Refund value. 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-tier or multiple-tier type. A single-tier refund sets a single refund value for all containers. A multiple-tier refund would distinguish among containers based on certain characteristics and establish differential refund values. For example, (1) containers made of particularly desirable raw materials could bear lower deposit values, while all others would require a higher mandatory deposit, and (2) 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.

Deposit redemption. A scheme for the redemption of the deposit on containers that are returned should be defined. Usually, dealers[57] and certified redemption centers 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 they sell, 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.[58]
- Whether dealers should be allowed to refuse beverage containers that are not clean when returned (and if so, what should be the appropriate standards of "reasonable" cleanliness)

Standards for labeling. Standards for container labeling should be set. The labeling requirements depend largely on the type of deposit refund structure—the number of tiers, etc.

Penalties. 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.

Oversight responsibility. Responsibility for the implementation, monitoring, and enforcement of the program should be given to a single bureau or public agency with adequate enforcement powers.

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 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 U.S. 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.[59] 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 in recent years has 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 5 percent of the total solid waste volume. Thus, a national deposit refund system may decrease total solid waste volume by no more than 2 percent.[60] Although a deposit law may reduce solid wastes to a greater or lesser extent, based on national consumer profiles, the issue is whether or not the reduction in itself warrants the adoption of a program that will force the beverage industry to modify the way it produces, distributes, and sells beverage containers.

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 the 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. In the case of glass bottles, however, 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.[61] It is also argued that shifting to refillable bottles will increase transportation costs.

This point is made only to show that 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.

Lead-Acid Batteries. Lead-acid batteries are often improperly disposed of in some industrialized countries. Most of the lead that enters landfills and incinerators in the United States comes from storage batteries.[62] Although a substantial amount of lead from motor-vehicle batteries is recycled in the United States each year, the share of batteries recycled has been decreasing during the last thirty years.[63]

A deposit refund system for lead-acid batteries is attractive primarily because it encourages the safe disposal of such 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 centers, 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 could 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 as much concern 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 becomes a problem because individuals in many countries have to pay to have their automobiles disposed of. 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.

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 or 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 rerefining 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 principal source of improper disposal.

A deposit refund system for used lubricating oils should focus on the smaller sectors. The simplest version of such a program would require consumers to pay a deposit to retailers for each quart of oil purchased. They could then receive a refund when they took the used oil to redemption centers. The program 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 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, such service stations might be discouraged from participation for fear of receiving oil contaminated with counterfeit substances.[64] In general, difficulties associated with detecting adulterating substances would pose a serious problem for the deposit refund system for lubricating oils.

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 center for disposal.

Tradeable Pollution Permits

Under this approach, the responsible regulatory authority sets a ceiling on the total allowable emissions of a pollutant. It then allocates this total amount of allowable emissions among the sources of the pollutant. It does this by issuing permits that 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 program. A trading program is also used for reducing water pollution in the Fox River in Wisconsin.

In 1988, a system of fully tradeable chlorofluorocarbons production permits was introduced by the United States as part of its program 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 program undertaken so far, the 1990 amendments to the U.S. Clean Air Act established a comprehensive tradeable permits system for SO_2 emissions from electric utilities. The first phase of the program, which begins in 1995, targets the power plants with the highest rates of SO_2 emissions. In the year 2000, the number of permits or allowances will be reduced, and the program will be extended to all power plants.

Tradeable permits offer a number of advantages:

- There is a high degree of confidence that pollution-control targets can be met.
- The scheme is flexible enough to accommodate growth in the industry without compromising environmental quality.
- Since the scheme deals with quantities (that is, 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, 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 program depends critically on the number of sources available for potential trades. The greater the number of sources targeted by the permit program, the greater the likelihood of free competitive trading.

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

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, that is, 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.

Seasonal and Episodic Controls. Some environmental problems vary greatly by season. For example, ground-level ozone is mainly a summer problem and, environmentally speaking, it would be undesirable to allow trading that would increase emissions in the summer months.

One way in which seasonal environmental problems could be addressed within a trading program would be to issue permits exclusively for 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.

Initial Allocation of Permits. When a trading program is first launched, the total number of permits must be allocated among the sources of pollution included in the program. 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 license 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 program.

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 shutdowns. 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 historical record.

From the standpoint of realizing the potential economic benefits of a trading program, there is little difference between the two options. Auctioning, however, may encourage the potential benefits to be realized sooner. Auctioning, if announced well in advance, for example, 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 that 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 depreciation stands as one of the main drawbacks to trading.

Monitoring and Enforcement. Once established, a trading program would require two types of monitoring: (1) the monitoring of emissions, as required under any regulatory program, and (2) the monitoring of trades. Under current regulations in most countries, large-scale sources of pollution—the kind most likely to be included in a tradeable permits program—are often responsible for monitoring and reporting emissions on a regular basis. This would continue under a trading program 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 willful 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.

Potential Barriers to Trading. For the potential economic benefits of an emissions trading program 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:

1. High transaction costs created by cumbersome and/or unclear trading rules established by the regulatory authority
2. The inability of willing buyers and sellers to identify one another
3. 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. Requiring prior approval of trades, for example, would make exchange cumbersome and inhibit trading. In addition, prior approval of trades does not necessarily ensure the integrity of the program.

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.

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 just pointed out, 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 that 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 program 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.

Chapter 6

Lessons Learned from the Use of Market-based Incentives to Control Pollution

Limitations of Market-based Incentives

To date, tax incentives designed to promote investments in pollution-control equipment have been the dominant form of fiscal instrument used by countries worldwide to combat pollution. As compared to regulatory controls, the use of MBIs is a promising alternative method for encouraging pollution abatement. At the same time, MBIs are not a panacea for the control of environmental damage. There are a number of difficulties associated with their use. These incentives, if not properly designed, may or may not assist in the long-run improvement of environmental quality.

First, if not properly designed, such tax incentives can create distortions in the choice of technology and length of asset life, leading to the selection of incentives that are both economically and environmentally inefficient. Second, the use of the tax system to assist in pollution control violates the polluter-pays principle since polluters receive tax incentives to invest in pollution-control equipment or to reduce emissions levels, but they are not made to pay directly for the costs of the environmental damage caused by the pollution. Third, the use of fiscal instruments to subsidize pollution-control investment in dirty industries may result in the subsidization of a broader range of investments, hence encouraging more activity in the sector than there would have been otherwise. The final result is that more total pollution may be created than if no incentive had been given for pollution-abatement equipment.

The fourth problem stems from the fact that many such tax incentives tend to be economically non-neutral, targeting both big and small enterprises in the same way, when the large enterprises are much more able to benefit from the tax incentives. Both tax incentives and investment taxes are generally difficult to administer because they cannot be easily targeted at individual industries or polluting companies. This is mainly because environmental taxes deal directly with the pollutants, which are emitted by various sources in different quantities, making it impossible to accurately determine which sources are more accountable for the overall ambient quality. This issue points to the difficulty of defining a base for such taxes. Governments have to decide whether to tax inputs that create pollution differently from the outputs of processes that generate pollution. They also have to determine how to deal with imported final goods whose production process in the country of origin causes pollution. Once the base is defined, there is still the problem of effective enforcement of the policy.

Of the market-based instruments now in use to control pollution, the most effective appear to be the deposit refund systems and tradeable pollution permits. One drawback of both of these systems is that they are only applicable to a subset of pollutants. Deposit refund systems work where the source of pollution is recyclable. If not properly designed, however, the deposits on recyclable items can make them too expensive and their purchase less attractive. In such situations, the vendors may try to find ways in which to circumvent the refund requirements, thereby reducing the effectiveness of the deposit refund system.

Tradeable pollution permits only work where the sources of the pollution are well defined and the amount of pollution generated by each firm is easily computed. The permit system is not broadly applicable to all polluters. Careful design of the system is essential. Pollution permits have to be industry specific and the pollutant has to be precisely defined. There are two problems that are associated with this requirement. First, there has to be agreement within the industry, or government, about how to restrict the level of specific pollutant in order to achieve acceptable pollution levels. Second, although specifying the industry may structure a particular industry's activities, the problem of multiple-source pollutants still has to be dealt with. The pollutant may be emitted by more than one industry. In such cases, there is no way to tell whether the emissions are coming from a failure to comply or whether they are the result of production in an industry that has not adopted pollution-control standards.

Recognizing the limitations of using such indirect methods to combat environmental damage, many of the countries in Asia, Europe, and North

America are considering other forms of market-based incentives that more clearly target the desired environmental objectives and that provide direct subsidies or taxes to achieve them. It is in this area that the important innovations in policy design are now occurring.

Conclusions

It is clear from the analysis of market-based incentives for the control of pollution 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 market-based incentives as well.

Appendix

Investment Tax Incentives for Pollution Control in Selected Countries in Asia, Europe, and North America

ASIA

Japan

The basic provisions dealing with national taxes on individuals and corporations are to be found in a series of statutes covering both specific and general topics. For corporations, the basic statute is the Corporate Tax Law (CAL), which is supplemented by cabinet orders and ministerial ordinances issued pursuant to each.

A combination of depreciation and expensing incentives are provided for certain eligible assets, which include pollution-control investments. The interplay of ordinary depreciation and the so-called "initial depreciation provision" (which is essentially a partial-expensing allowance), in addition to an obsolescence clause for shortening useful asset lives, results in an attractive investment tax incentive for pollution-control equipment.

No investment tax credits are provided under the Japanese CAL.

Ordinary Depreciation. Most assets eligible for ordinary depreciation may be depreciated using the straight-line method, the declining-balance method, or any other method specifically approved by the relevant regional tax bureau. For accounting purposes, a corporation may treat ordinary depreciation charges as a reduction in the book value of the asset or as a credit to an ordinary depreciation reserve account.[65] Depreciation, as entered on the books of the company, may be deducted for tax purposes and may be charged against profits, up to the limits established by law.[66]

Depreciation entered on the books in excess of the statutory limits may not be deducted currently, but may be carried over and, taken together with subsequent book depreciation, deducted up to the statutory limits in subsequent years.[67]

A ministerial ordinance stipulates that machinery used for pollution control should have a useful life span of seven years. Specially constructed structures, such as towers, reinforced concrete buildings, chimneys over seventy meters high, etc., have varying useful life spans, ranging from ten to thirty years.[68]

Shortening of Useful Life Due to Obsolescence. Upon application to the tax authorities, the useful life of an asset may be shortened on grounds of functional obsolescence. Depreciation for the previous years may be recomputed based on the shorter life and the excess of depreciation (as computed over the depreciation actually deducted during those years) may be currently expensed.

Special Accelerated (Initial) Depreciation. Under the "special initial depreciation" method,[69] a certain percentage of the acquisition costs of eligible assets may be deducted once during the year when the assets are first placed in use. Examples of the amount of the special initial depreciation allowed are as follows:[70]

- Qualified facilities to prevent pollution: 25 percent of acquisition cost
- Qualified plants equipped with special antipollution devices and qualified energy-efficient plants: 18 percent of acquisition cost
- Certain energy-saving machinery: 18 percent of acquisition cost

The special initial depreciation may be accounted for in the normal way by reducing the book value of the assets, thus decreasing the amount of depreciation in future years. Alternatively, these amounts may be credited to a special depreciation reserve account, in which case book value is not reduced and ordinary depreciation may be taken on the basis of the higher value. This accounting option allows an investor to choose between immediate partial expensing and the use of normal depreciation. This enables the investor to select a scheme that more closely matches the investor's cash flow.

Eligibility for the special accelerated-depreciation benefits is conditioned upon a corporation filing a so-called *blue return*. The blue return was originally established to encourage the use of standardized accounting procedures. Corporations that apply for the privilege of filing a blue return and agree to use a standard bookkeeping system are eligible for very substantial tax benefits.

They may:

- Carry losses over five years and back one
- Establish certain special tax-incentive reserve accounts and take certain tax-incentive deductions and credits
- Use accelerated depreciation or initial depreciation with respect to certain assets

Korea

The Corporation Tax Law (CTL) in Korea provides the basic operative guidelines for income reporting and taxation. The Tax Exemption and Reduction Control Law (TERCL)[71] provides tax incentives and regulates those specified in twenty-two other statutes, such as the Income Tax Law, the Value-added Tax Law, the Local Tax Law, and the Corporation Tax Law itself. There are two provisions within the TERCL that directly and indirectly provide incentives for pollution control.

There is a direct investment tax credit of 3 percent (or 10 percent for equipment made in Korea) of the value of the investment. This credit is restricted to those resident or domestic corporations investing in one of the following:[72]

- Facilities for increasing productivity
- Energy-saving facilities
- Antipollution facilities
- Facilities for preventing industrial hazards
- Other specified facilities

More indirectly, there is a choice between accelerated depreciation and investment credits for persons who start a business using new technology

atented in Korea or developed by institutions designated through consultations between the Ministry of Finance and the Ministry of Science and Technology.[73] Investors have a choice between:

- An investment credit at the rate of 3 percent (or 10 percent in the case of machinery made in Korea) of the value of the investment in new assets
- A depreciation of 30 percent (50 percent in the case of machinery manufactured in Korea) of the asset's acquisition price in the fiscal year of acquisition

We call this incentive provision indirect only because the law does not specifically list pollution-control investments as being approved new technology. However, the statute is broad enough to permit the inclusion of pollution-control technologies. Since pollution-control equipment is often considered to be part of manufacturing equipment, it qualifies for the incentive, particularly when its purchase costs are combined with process-modification costs.

Three methods for depreciating assets are defined in the Corporation Tax Law:[74] (1) the straight-line method, (2) the declining-balance method, and (3) the unit-of-production method. Only one of the first two can be selected by taxpayers for the depreciation of tangible fixed assets—pollution-control equipment will fall under this category. Intangible fixed assets must use the straight-line method. The unit-of-production method is available only to depreciate mineral rights.

Singapore

While providing a number of incentives for certain explicitly favored activities, the government provides no preferences whatsoever for environmental protection investments. Singapore provides a number of other incentives, such as investment credits, tax holidays, and concessionary tax rates—none of which are available for environmental protection purposes. In brief, Singapore's investment objectives and strategies focus upon the incorporation of high technology for manufacturing, trade, tourism, transport, communications, and "brain services." The latter includes computer, financial, medical, and consulting services.

Notwithstanding the absence of preferences for pollution-control

investments, the depreciation provisions are generous. All categories of taxpayers who are carrying on a trade, business, or profession can choose to depreciate all classes of plant and equipment, except motor vehicles, in three years following the year of purchase.[75]

To facilitate the absorption of depreciation allowances, unused allowances may be carried forward indefinitely or set off against future profits.[76] In the case of companies, the same continuity-of-ownership test applicable for losses must be met in order to carry over depreciation allowances.[77] The minister may dispense with the test if satisfied that the change of ownership is not for the purpose of deriving any tax benefit or obtaining a tax advantage.[78]

Taiwan

Investments in pollution-control equipment and energy-saving devices were first accorded special treatment in 1970, when the existing Statute for Encouraging Industry (SEI) was extended. Current investment incentive provisions are contained in the Statute for Upgrading Industry (SUI).[79]

Investment tax incentives for pollution control allowed by the SUI include accelerated depreciation, investment tax credits, share-purchase tax credits, tax exemption on retained earnings, and tax deferral on stock dividends.

Accelerated Depreciation. Under the earlier Statute for Encouraging Investment, investments in pollution-control equipment could be depreciated over a period of two years (straight-line).[80] The present Statute for Upgrading Industry allows the depreciation of certified investments to be accelerated by up to half the number of years of normal service life, as specified in the Income Tax Law. Although the law is not explicitly drafted to include pollution-control equipment, the wording is sufficiently broad to technically include such investments. It states,

> Based on the requirements for adjustment of industrial structure and improvement of scale of operations and methods of production, depreciation of the machinery and equipment of specifically designated industries may be accelerated by one half the number of years of service life of fixed assets as prescribed in the income tax law.[81]

If the residual period after depreciation is less than one year, it is not counted, that is, full depreciation will be completed in the earlier period.[82]

Investment Tax Credits. Available investment tax credits range from 5 to 20 percent of the investment on equipment or technologies used for production automation, pollution control, personnel training, or the establishment of international brand names. There must be a minimum investment of NT$600,000 in the particular taxable year. The total amount of credit allowed in a given year is limited to 50 percent of the corporate income tax payable in that year. If the credit exceeds the mandated limitation, it may be carried over for a period of four years.

According to the enforcement rules of the SUI, the credit is graduated as follows:

- 20 percent for pollution-control equipment procured domestically
- 15 percent for pollution-control equipment procured abroad
- 5 percent for pollution-control technologies procured either domestically or abroad

These credits are available only for funds spent on pollution-control equipment or technologies within five years from the effective date of the statute.

Share-purchase Tax Credits. Investors holding registered shares in "important technological industries" (which may include firms engaged in the development and production of pollution-control equipment) for a period of more than two years can credit up to 20 percent of the price paid for the acquisition of such stocks against their income tax. If the share-purchase credit is greater than the tax payable, the balance of the creditable amount can be carried over for a period of four years.

Tax-exemption on Retained Earnings. The SUI allows a corporation to retain undistributed earnings (also called retained profits) up to twice its accumulated paid-up capital, which is exempt from the 10 percent profit-seeking enterprise income tax if the funds are used for certain specified purposes.[83] Such purposes include:

- Purchasing various classes of products, including pollution-control equipment
- Repaying loans borrowed for the purpose of purchasing the aforesaid equipment

- Investing in certain important industries specified by the government[84]

According to the Income Tax Law, if the accumulated retained profits of a company exceed half of the total paid-up capital in a year, in the following business year the company must distribute the accumulated retained earnings in the form of dividends to its shareholders.[85] Undistributed accumulated profits in excess of half of the total paid-up capital in a year can be included in the taxable income of the shareholder if there is no stock distribution. The local tax administration will compute the distributable profits (above the 50 percent of paid-up capital limit) allocable to each shareholder and levy a 10 percent profit-seeking enterprise income tax on each shareholder for the current taxable year.[86]

Tax Deferral on Stock Dividends. If a registered stock dividend is newly issued by a corporate enterprise from its undistributed earnings for certain approved purposes (see the previous section), the tax on the stock dividends is deferred until the shares are sold. These dividends may be in the form of bonus share issues or may result from the paying company's capitalization of retained earnings. Neither of these stock dividends will be included in the consolidated income of the corporate shareholder.[87]

EUROPE

France

The general guidelines concerning tax incentives are contained in the *Code general des impots* (the general tax code). Both straight-line and declining-balance depreciation are available. However, straight-line depreciation is usually used for most plant and machinery. Since there are no official rates, acceptable rates of depreciation under the straight-line method are normally consistent with rates used by business and industry. Rates for machinery range from 10 to 20 percent. Depreciation must correspond to the useful life customarily associated with a particular activity, although an administrative tolerance of 20 percent is allowed.

Accelerated depreciation is available for certain assets, including pollution-control equipment. Immovable installations for the purification of water and air can be depreciated by 50 percent straight-line in the first year.

The French law has a number of investment incentives, such as regional tax concessions and grants. None are specifically slated for investments in pollution-control equipment. However, some will definitely reduce the effective burden of environmental regulation. The number of possible tax preference outcomes vary by industry, location, and product characteristics and are difficult to predict with any certainty.

Germany

The German tax law, *Einkommensteuergesetz* (EStG), provides accelerated depreciation or initial expensing provisions for assets used for pollution control. The basis of depreciation is the cost of acquisition or manufacturing. Immovable assets can as a rule be depreciated only by using the straight-line method. On the other hand, in the case of movable fixed assets, straight-line, three-times-declining-balance, and the production basis methods are permitted. Where the declining-balance method is used, the rate may not exceed 30 percent.[88] The generally accepted straight-line rate for machinery is 10 to 12 percent.

Accelerated depreciation is allowed for personal and immovable assets serving the purposes of environmental protection (air pollution, water pollution, noise protection, etc). There is an initial allowance of 60 percent, followed by an annual depreciation rate of 10 percent until full amortization.[89]

One interesting feature of the German law is the stipulation of a qualification clause in order for pollution-control equipment to be eligible for accelerated depreciation. Eligibility is based on the percentage of equipment that is intended for pollution abatement. Qualifying equipment is defined as serving more than 70 percent for the purpose of reducing air, water, or noise pollution.

According to current legislation, accelerated depreciation for anti-pollution equipment is available only for assets acquired or produced before December 31, 1991.[90]

There are no investment tax credits in Germany.

The Netherlands

The Netherlands allows the taxpayer to choose any suitable method of depreciation, provided it is in accordance with generally accepted

accounting principles and "sound business practice." Once a method is chosen, it must be used consistently. For each different kind of asset, a different method may be adopted. Straight-line depreciation is commonly used by taxpayers and generally accepted by the tax administration. Machinery and equipment are generally depreciated at rates ranging from 10 to 20 percent.

Accelerated depreciation and investment allowances that were permitted by an earlier law have been replaced by investment tax credits. Credits ranging from 3 to 15 percent, depending on the type of asset, are available for investments in pollution control, or "investments for implementing environmental policies."[91]

Environmentally beneficial products or techniques are eligible for grants and loans to assist in their manufacture or implementation. Financial aid can also be obtained for certain projects promoting the development, application, and demonstration of environmentally sound projects. These projects should include the development of new machinery, systems, or techniques that have the effect of reducing or eliminating pollution.[92]

A law has been proposed that would permit the immediate and full expensing of investments in assets that may contribute to a cleaner environment. Under this law, the pollution-control asset would be fully written off as an expense in the year in which it was purchased. The bill is still pending.[93]

United Kingdom

There are no investment incentives for installing pollution-control equipment in production facilities in the United Kingdom. The only antipollution expenditure that is eligible for a deduction is the cost incurred when closing down an oil field (or part of a field) in order to minimize the environmental impact. This deduction is allowable only against a capital-gains tax liability.[94]

The U.K. tax code is fairly generous as regards tax incentives for the research and development of pollution-control technologies and equipment. In order to support research in environmental protection products and technologies, two provisions have been made available.

Tax Credit for Environmental R&D. In 1988, the Department of the Environment set up the Environmental Protection Technology Scheme. Under the scheme, the government may provide up to 50 percent of the

cost of industrial research projects aimed at improving environmental standards.

Immediate Expensing of R&D Capital Expenditures. Companies making capital expenditures on scientific research (not necessarily in the field of pollution control) are eligible for a capital allowance equal to 100 percent. Another condition for this tax relief is that the company must be carrying on, or about to commence, trade related to the expenditure.[95]

NORTH AMERICA

Canada

Incentives within the income tax system generally reduce both the provincial and federal taxes payable. Ontario, Quebec, and Alberta, the three provinces that do not participate in the federal/provincial corporate tax collection agreements, follow the federal government's treatment of pollution-control equipment for capital cost allowance (CCA) purposes.

In general, the Canadian system of capital cost allowances operates on a pool basis, with separate classes provided for various types of property acquired for the purpose of earning income. The capital cost of each asset is added to the appropriate pool or class. Each class is then reduced by the specific capital allowance permitted.

Under Canada's Income Tax Act, a taxpayer who has acquired an *unused* depreciable property primarily for the purposes of "preventing, reducing, or eliminating [water or air] pollution" from one of three types of operations can apply to the minister of environment for approval to depreciate this property at an accelerated rate.[96] The three types of operations are:

- Operations carried on before 1974 at a site in Canada
- Operations carried on in Canada at a plant that was under construction prior to 1974 (a plant is deemed to have been under construction if an agreement to build it was signed before 1974)
- Operations carried on through the employment of movable equipment in Canada prior to 1974

The Income Tax Act also allows taxpayers who lease pollution-control equipment to persons carrying on eligible operations and taxpayers who are in the business of reducing pollution from eligible operations to write off their investments at the same accelerated rates.

The Income Tax Act does not contain comparable provisions for post-1973 operations. Thus, the class of taxpayers who are eligible to benefit from the program becomes smaller every time pre-1974 operations are permanently discontinued. There are, however, no restrictions on the number of pollution-control properties and no limits on expenditures that may be approved by the minister of the environment.

Qualified and approved water pollution control equipment falls into Class 24 of Canada's CCA system, while qualified and approved air pollution control equipment falls into Class 27 of the CCA system. In both of these cases, properties acquired after November 12, 1981, may be depreciated by claiming a maximum capital cost allowance of 25 percent in the year of acquisition, 50 percent in the second year of ownership, and 25 percent in the third year. Thus, a depreciable property that was acquired primarily for the purpose of preventing, reducing, or eliminating water or air pollution from eligible pre-1974 operations can usually be written off over three years.

Although not designed for environmental purposes, both Quebec and Ontario offer investment tax credits (ITCs) for the purchase of manufacturing and processing machinery. These may include pollution-abatement and pollution-control equipment. The general investment tax credit applicable in most regions of Canada was eliminated for 1989 and subsequent years. The current ITC provisions are intended to stimulate new investment over a wide range of commercial activity, with special treatment given to certain taxpayers and regions and specific types of investment. Actual ITCs are taken against the cost of certain assets and expenditures and vary depending upon the taxpayer, activity, region, and year involved.

The 1991 Quebec budget made environmental technology innovation projects eligible for special R&D incentives, including a refundable tax credit. Ontario also provides income tax incentives for investments in manufacturing, processing, and pollution-control equipment.

United States

Pollution-control investments are not accorded special incentives under the U.S. income tax statute. Limited investment credits for the purchase of

certain depreciable property were made unavailable for assets placed in service after 1985.

The depreciation of plant and equipment is based on the 1981 Accelerated Cost Recovery System (ACRS) and the modified ACRS, which went into effect in 1986. The cost of property acquired after December 31, 1986, is recovered over a three-, five-, seven-, ten-, fifteen-, or twenty-year period, depending on the type of property. Cost recovery methods and periods are the same for both new and used property.

Property classes are chosen by broad process-unit characteristics. This means that all equipment in a particular plant, except for structural buildings, will be given a single classification. There is no distinction between machinery and equipment used for pollution control and that used for other purposes.

Notes

1. Regulation continues to be the most suitable method of restricting the emission of toxic chemicals and compounds.

2. U.S. Environmental Protection Agency 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 percent), local governments (22.5 percent), the federal government (11 percent), and state governments (3.5 percent).

3. Jorgenson and Wilcoxen 1992, 8–13.

4. See Baumol and Oates 1988 and Tietenberg 1988. Both books have a good textbook treatment of the theory.

5. These costs may differ owing to transaction costs and behavioral inertia on the part of the polluter.

6. Coase 1960, 7–44.

7. Organization for Economic Cooperation and Development 1986, 20.

8. Ibid, 27.

9. United Kingdom Secretary of State for Environment and others, *This Common Inheritance,* Common Service 6, No. 1200, p. 271, 1990. 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 Cost of Keeping Clean," *The Economist* 316, no. 7668 (August 18, 1990), 47–48.

10. This section of the book draws on p. 4 of Stavins and Whitehead 1992.

11. Tietenberg 1985.

12. See Bohm and Russell 1985.

13. Alm 1989, 1338–39.

14. See Bohm and Russell 1985.

15. Panayotou 1991a, 98–101.

16. Harberger 1980, 299.

17. Bird 1980, 19.

18. Harberger 1980, 303–4.
19. Musgrave 1959, 343.
20. U.S. Senate Report 1975.
21. Feldstein 1982, 153–67.
22. From Harberger 1988. The original idea is attributed to Cary Brown.
23. Panayotou 1991a, 96–97.
24. Ibid.
25. The word "excessive" is used because such behavior runs counter to rational profit maximization.
26. H. David Robinson, *Canadian Journal of Economics* 1 (1988), 187–199.
27. U.S. General Accounting Office 1982.
28. Jorgenson and Wilcoxen 1992, 13.
29. Ibid, 16–19.
30. Usher 1977, 119.
31. Harberger 1980, 299.
32. MacKnight 1990, 10:2.
33. Hull and St-Pierre 1990, 19.
34. Jenkins 1991, 7:3–7:41.
35. Provisions of the Economic Recovery Tax Act (ERTA) of 1981, Public Law No. 97-34, 95 Stat. 172 (1981), U.S. Internal Revenue Code.
36. MacKnight 1990, 10:3.
37. Bird 1980, 52.
38. Kierans 1972.
39. International Bureau of Fiscal Documentation, Taxation in Asia and Pacific, Taiwan, Supplement No. 87, November 1991, Taiwan–58a.
40. Ibid.
41. Japanese Minister of Finance Notification No. 69, Table 1, May 29, 1973; Sangyo to Kogai (Industry and Pollution).
42. This geographical boundary should effectively encompass the zone of environmental concern. It could be a small local-government jurisdiction or extend across a nation or group of nations (for example, the European Economic Community [EEC]).
43. U.S. Public Law 92-500, 86 Stat. 880 (codified as amended at 33 U.S.C. section 1342[b] [1982]).
44. See, for example, Wickard v. Filburn, 317 U.S. 111 (1942); Perez v. United States, 402 U.S. 146 (1971).
45. See, for example, the Clean Water Act, 33 U.S.C. section 1370 (1982); also, the Resources Conservation and Recovery Act of 1976, 42 U.S.C. sections 6948, 6947 (1982).
46. 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.
47. *Abwasserabgabengetz* (1976), that is, Effluent Charge Law (ECL), article 3(1).
48. For a more detailed discussion of the ECL, see Brown and Johnson 1984, 929–66.
49. ECL, article 4(4).
50. For example, chemical oxygen demand (COD), mercury, and cadmium discharges

are based on production volumes, whereas settleable solids and toxicity toward fish are based per unit of wastewater discharged.

51. ECL, article 9(4).

52. Sections 4681 and 4682 of the Revenue Reconciliation Act (1989, effective January 1, 1990) outline the taxation of the sale and use of such ozone-depleting substances. The Internal Revenue Service (IRS) has provided guidance for implementing the excise tax on ozone-depleting chemicals in Notice 90–8, IRB 1990–5, 14, and Notice 90–9, IRB 1990–5, 21.

53. D. Olivry, *OECD Case Study for France*, ENV/ECO/86.10.

54. Brown and Johnson 1984, 929–66.

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

56. Senate Bill 38, sec. 10–213.4, Virginia General Assembly.

57. Persons engaged in the sale of beverages and beverage containers to consumers.

58. Most states in the United States with mandatory deposit refund schemes have instituted a handling fee equal to 20 percent of the value of the deposit.

59. Environmental Action Foundation, Briefing Papers: Litter Reduction 2, as quoted in Weinberg 1987.

60. See Weinberg 1987, 194.

61. National Soft Drink Association, *Forced Deposit Laws . . . There Are No Winners*, U.S.A, 1985.

62. See Stavins and Whitehead 1992, 28.

63. In 1955, the recovery rate of used motor-vehicle batteries was over 90 percent; by 1988, it was approximately 75 percent. 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. 1986.

64. Anderson, Hofmann, and Rusin 1990.

65. Report of MOF Committee on Business Accounting Principles as amended August 30, 1974, Note 17.

66. Corporation Tax Law, Articles 31, 32.

67. Corporation Tax Law, Basic Circular Section 7–5–1.

68. Tables 6 and 7, *Ministerial Ordinance Concerning the Useful Life of Depreciable Assets*, Ministry of Finance Ordinance No. 15, March 31, 1965, as last amended by Ordinance No. 17, March 31, 1990.

69. Law No. 26, March 31, 1957, as last amended by Law No. 15, March 31, 1990. Cabinet Order No. 43, March 31, 1957, as last amended by Cabinet Order No. 93, March 31, 1990.

70. Special Tax Measures Law (STML) Article 43.

71. Law No. 1723 of 1965.

72. TERCL, Article 71 and Article 18(1).

73. TERCL, Article 18, and TERCL–Executive Decree, Article 15.

74. CTL, Article 56.

75. The Income Tax Act, Article 19A.

76. The Income Tax Act (Cap. 134), Section 23(1).

77. Ibid, Section 23(3).

78. Ibid, Section 23(2A).

79. Statute for Upgrading Industry (SUI), promulgated on December 29, 1990, by presidential decree. It is effective from January 1, 1991, until June 30, 1998.

80. Article 51 of the 1990 Income Tax Law.

81. *Taxation in the Republic of China,* Ministry of Finance, 1991.

82. Article 5, Statute for Upgrading Industry.

83. The retained earnings is the amount of profit-seeking income determined by the administration after deducting:

- The profit-seeking enterprise tax amount in the taxable year
- Previous losses
- Dividends to be distributed upon resolution of the shareholders' meeting
- Legal reserve funds set aside according to company law
- Bonuses paid to directors and employees
- Other items permitted by the Ministry of Finance

See International Bureau of Fiscal Documentation, Taiwan, Supplement No. 81, May 1991.

84. The list of eligible products and designated industries are specified by the Executive Yuan, with a revision option every two years.

85. Article 76–1, Income Tax Law.

86. Article 88, Income Tax Law.

87. Statute for Upgrading Industry, Article 16, December 29, 1990.

88. Section 7(2) *Einkommensteuergesetz* (Income Tax Code).

89. Section 7(d), *Einkommensteuergesetz.*

90. *Einkommensteuergesetz* (Income Tax Code), as repromulgated September 7, 1990, see *Bundesgesetzblatt* I (BGBI, official law gazette of the Federal Republic of Germany), p. 1898, section 7d.

91. The Taxation of Companies in Europe, Netherlands—53, Corporate Income Tax, Supplement No. 95, February 1991, International Bureau of Fiscal Documentation.

92. *Doing Business in the Netherlands,* Price Waterhouse, December 1990, 32.

93. Ibid, note 27.

94. Oil Taxation Act, Chapter 22, Article 3, 1975.

95. Capital Allowances Act, Chapter 1, Articles 137 and 138, 1990.

96. See the Department of National Revenue's Interpretation, Bulletin IT-336R, published in Volume 8, *Canadian Tax Reporter,* Information Circulars and Interpretation Bulletins, 1985, 33, 399, 401–4.

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